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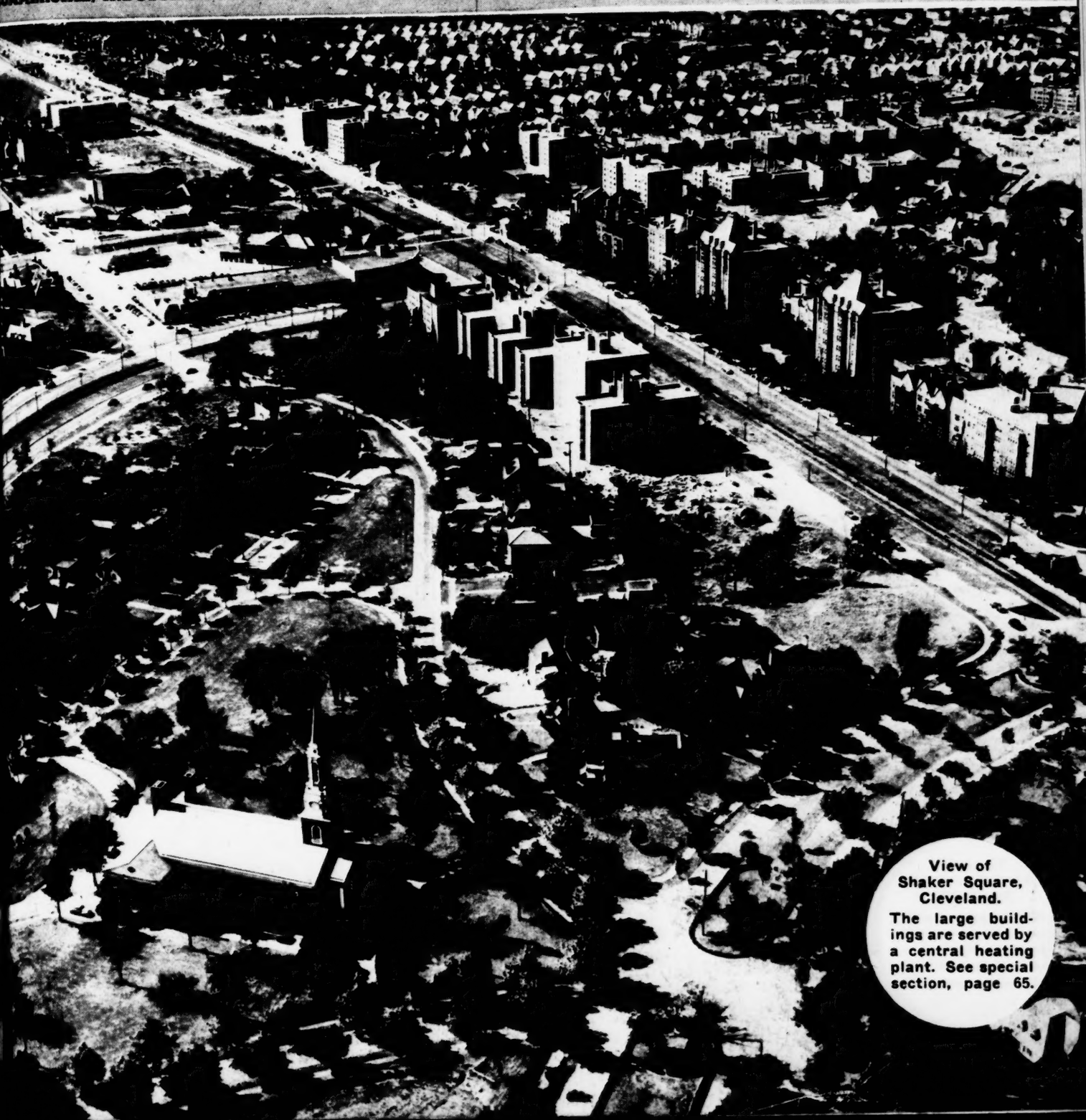

View of Shaker Square, Cleveland.

The large buildings are served by a central heating plant. See special section, page 65.

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A MONTHLY
MAGAZINE FOR ENGINEERS
AND CONTRACTORS CONCERNED WITH
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DECATUR (ZONE A) ILLINOIS

Fig. 1. Odors of many types are discharged into the atmosphere through smoke stacks and exhaust vents to become a major problem in some districts.

Atmospheric Pollution Through Odor

ARTHUR C. STERN

WHY one odor is pleasant and another unpleasant we do not yet know. But we do know that almost all of our atmospheric odor problems involve air contamination by unpleasant odors rather than pleasant ones. What we mean when we classify an odor as unpleasant is concisely summarized in the following paragraph from a report[1] of a study of pleasant and unpleasant odors.

> "Odors vary from those which are considered very pleasant and are highly prized in perfumery to those which are considered foul and disgusting stenches. In between lies a wide range of characteristic odors on the nature of which there is no unanimity of opinion; for example, the odor of amyl acetate (banana oil) is pleasant to some persons, tolerable to others, and offensive and nauseating to a third group. An increase in the intensity of a so-called pleasant odor puts it in the unpleasant class; likewise malodorous substances are often tolerable or even pleasant in extremely high dilution with air. Thus, the sweet odor of the geranium plant can be simulated by faint concentrations of diphenyl ether, which is the aromatic essence of that plant; but in higher concentrations it becomes repulsive."

It is a moot point as to when an objectionable odor becomes injurious to human health. This is so because the extent of failure of the appetite, or of psychological depression, due to repeated exposure to such a respiratory environment, and of shallow breathing while in the environment varies greatly between individuals and is largely unmeasurable.

There are, of course, a group of odorous gases and vapors, of known toxic properties in low concentration, which form the stock in trade of the Chemical Warfare Service. The distinction between a war gas and an objectionable industrial effluent is somewhat tenuous and may merely be one of concentration. The most likely substance to be found in both categories is chlorine. Despite the widespread peacetime use of chlorine, exposures to concentrations detectable by odor occur under non-military circumstances only as the result of an accident such as a rupture of a cylinder of the gas, a break in a liquid line, or a leaky connection, because no work can be carried on in such an atmosphere.

With the possible exception of chlorine and phosgene, war gases have until now had little peacetime use other than by the police and as warning agents in fuel and compressed gases. It is, of course, impossible to predict the extent of their post-war industrial use but it is highly unlikely that any other war gas will be exhausted as industrial process effluents in sufficient quantity to cause an atmospheric pollution problem.

In a few instances pleasant odors may be considered as air contaminants in the sense that, despite their fragrance, the presence of the odor in the atmosphere is objectionable. Experience has shown that this is most likely to occur in neighborhoods

[1]Fieldner, A. C.; Sayers, R. R.; Vant, W. P.; Katz, S. H.; Shohan, J. B.; and Leitch, R. D.; Warning Agents for Fuel Gases, U. S. Bureau of Mines, Monograph 4, 1931.

where extensive baking and cooking operations occur, or where spices and grains are stored and milled. Certainly a restaurant owner in such a neighborhood has a legitimate complaint if his customers must eat in an atmosphere which masks beyond recognition the delectable aroma and flavor of his foods. The solutions to his problem are essentially no different than those employed in remedying conditions involving unpleasant odors.

Odorous Substances and Sources

Odors affect us both as a smell and as a so-called "trigeminal" (stinging, burning, hot or cool) sensation. Thus the stinging sensation of ammonia is very different from the sensation of smell alone experienced with a purely odorous substance such as coffee. The lachrymation (tear formation) and respiratory irritation experienced after exposure to higher concentrations of some of the more common substances of high trigeminal effect must not be confused with this effect. The trigeminal effect is one of the distinguishing characteristics allowing recognition of an odor in very low concentration, whereas lachrymation or irritation is a response of the body to relatively high concentration and gives one no clue as to the identity of the causative agent. Substances with marked trigeminal effect are not, of necessity, more objectionable or unpleasant than other odors, but any atmospheric contaminant present in sufficient concentration to cause the eyes to tear or the throat to become sore is, without question, objectionable. Chlorine, ammonia and sulfur dioxide are the atmospheric contaminants most apt in this class.

The chemical groups most commonly associated with unpleasant odor are the sulfides; disulfides; mercaptans; thiocyanates; isocyanides; compounds analogous to the foregoing of selenium or tellurium, and aldehydes. When it is realized that many of these substances are recognizable as malodorous at less than 0.1 ppm, some at as low as 0.0000001 ppm, the true nature of the odor problem may be seen.

The most probable sources of these odors, as listed in the New York City Sanitary Code, are:

> "Bone crushing, bone boiling, bone grinding, bone or shell burning, lime making, horse skinning, cow skinning, glue making from any part of dead animals, gut cleaning, hide curing, fat rendering, boiling of fish, swill or offal, heating, drying or storing of blood, scrap, fat, grease or other offensive animal matter or of offensive vegetable matter, or manufacturing materials for manure or fertilizer, slaughter of cattle, sheep, goats, pigs, calves or poultry, slaughter of horses, tanning, skinning or scouring or dressing hides or leather, rendering or melting fat, manufacturing or preparing sausages, or smoking or preserving meat or fish, boiling any varnish or oil, the distilling of any ardent or alcoholic spirits, making any lampblack, turpentine or tar, the treatment and refining of ores, metals or alloys of metals with acids or heat."

TABLE 1.—ODOR MEASUREMENT SCALE

Degree Odor	Designation	Description
0	No odor	No detectable odor
1	Very faint	Minimum positively perceptible.
2	Faint	Weak, readily perceptible.
3	Easily noticeable	Moderate odor.
4	Strong	Forcible odor.
5	Very strong	Intense effect.
Irritation		
0	None	No irritating effects
1	Slight	Just perceptible.
2	Moderate	Midway between 1 and 3.
3	Strong	Discomforting, but may be endured.
4	Intolerable	Exceedingly painful.

In the course of his work, the ventilating engineer will have need of a means for measuring the diminution of odor resulting from his endeavors. There is no satisfactory device commercially available for this purpose. One way in which odor in air may be measured is to pass a stream of the air through a trap which will remove and concentrate it to the point that sufficient odor substance is accumulated for weighing and analysis. Attempts to use activated carbon for this purpose have not been successful because of the difficulty of recovering from it unchanged the adsorbed odor substance. Passing a measured quantity of air through a tube packed in dry ice to freeze out the odor substance yields a sample which, although mixed with water vapor, and all other vapors that were in the air in non-odorous concentrations, may contain the odor body sought. For use in the hands of a ventilating engineer, a measurement method based on the sense of smell alone is, however, preferable to these methods.

Odor Intensity Scale

The simplest method based on the sense of smell involves setting up an arbitrary scale of odor intensity and having several observers record their estimates based upon this scale. A typical scale, used by the Bureau of Mines,[2] is shown in Table 1. In using this scale observers in an odor free room occasionally sniffed odorous gases from a box which was at all times exhausted to the outdoors. Similarly, the observer who desires to measure odor intensity in a polluted atmosphere by formulating and using a similar scale had best breathe odor free air from a mask for a while before sniffing the atmosphere and estimating its odor intensity. Otherwise the adverse effects of odor fatigue will make direct field use of a scale of odor intensities well nigh impossible.

The accepted technique for precise odor measurement requires the determination by the sense of smell of the threshold odor concentration, i.e. the concentration at which the nose first detects the odor. To measure the odor intensity of odorous air, we therefore (a) mask the observer (air supply drawn through an activated carbon canister or from a cylinder of odor free compressed air), (b) use an odor free diluent from a similar source, and (c) suc-

[2]Fieldner, A. C., et al — Loc. Cit.

cessively mix larger and larger measured quantities of the odorous atmosphere with it until the observer first notices the odor. The extent of dilution required will measure the intensity of atmospheric odor, and by comparing this intensity before and after odor control is attempted, the degree of odor reduction may be objectively evaluated.

It has been demonstrated that odor levels vary as the logarithm of the concentration of odorous substance in air.

In the case of sound, the fact that sound level is in proportion to the logarithm of the sound energy has led to the use of the now familiar decibel scale of measurement of sound level. This is the reason that the dilutions used in threshold odor intensity measurements must be converted to odor intensities on a logarithmic basis. Concentration of odorous substance in air can, therefore, be determined by osmoscope only when we know by experiment the concentration necessary to cause threshold odor perception—Table 2.[3]

Dilution Osmoscopes

An osmoscope has been patented by Pollak and Wellingham[4] in which continuous streams of odorous and odor free air are mixed in varying ratio and then fed to a masked observer. The osmoscopes devised by the author work on an entirely different basic principle, in that the measured mixture of odorous and odor free air is injected into the nose of the masked observer in small doses and at constant velocity. This is based upon the findings of Elsberg, Levy and Brewer[5] that impinging odorous substances onto the olfactory buds of the nose at constant velocity yields more consistent results than inhalation. In the latter case the impingement velocity varies with the rate of inhalation. Insofar as odor threshold apparently is a function of impingement velocity, this velocity must be held constant in order to obtain reproduceable results. The author's design of osmoscope is portable and eliminates the pumps, flow meters, and similar apparatus required by continuous flow dilution devices.

In its simplest form, the measuring element of this osmoscope, Fig. 2A, consists of cylinder *A* and piston *B*, having calibrated piston rod *C* with graduations marked thereon to indicate the per cent the volume above the piston bears to the total internal volume of the cylinder, i.e. per cent dilution by odor free air. If increased sensitivity is desired, the bottom of the cylinder and piston may contain a smaller diameter section *D*, Fig. 2B, as indicated. The air, the odor intensity of which is to be measured, enters the lower part of the cylinder through valve *E* when the latter is opened to the atmosphere, and the odor free air is drawn into the upper part of the cylinder through valve *F* when the latter is opened to the adsorbent canister *G*. The piston is then set at the desired test setting of per cent dilution with odor free air and valves *E* and *F* are closed. The samples below and above the piston must now be well mixed by uncovering the ports in piston *H* and reciprocating the piston several times.

The same result may be accomplished by means of an unported piston using outside mixing piping and an auxiliary valve, Fig. 2B, or by using a dual cylinder, Fig. 2C. In the latter case, the small cylinder measures the odorous air and injects it into a a large mixing cylinder of odor free air. After the

[3]Katz, S. H. and Talbert, E. J. Intensities of Odors and Irritating Effects of Warning Agents for Inflammable and Poisonous Gases. U. S. Bureau of Mines Tech. Paper 480, 1930.

[4]U. S. Patent 2,327,060.

[5]Elsberg, C. A.; Levy, I. and Brewer, E. D., The Sense of Smell, Bulletin of the Neurological Institute of New York, Vol. IV, No. 1-3, March-October-December 1935.

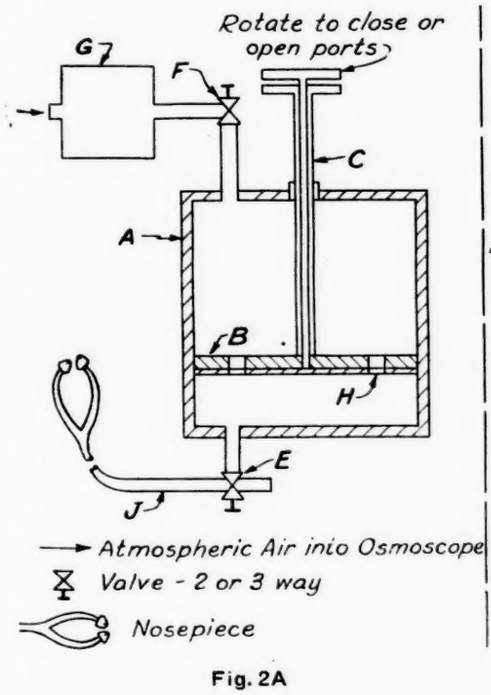


Fig. 2A

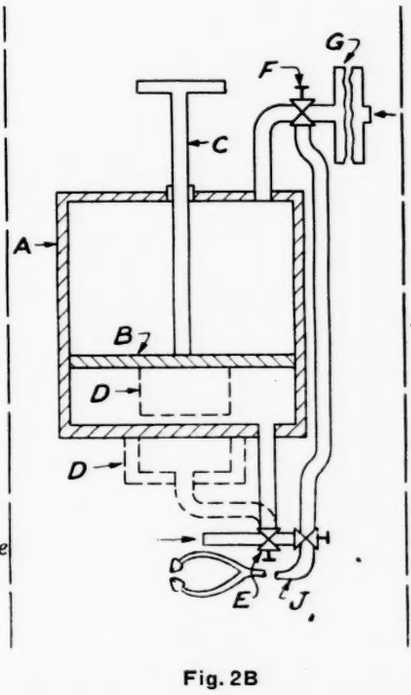


Fig. 2B

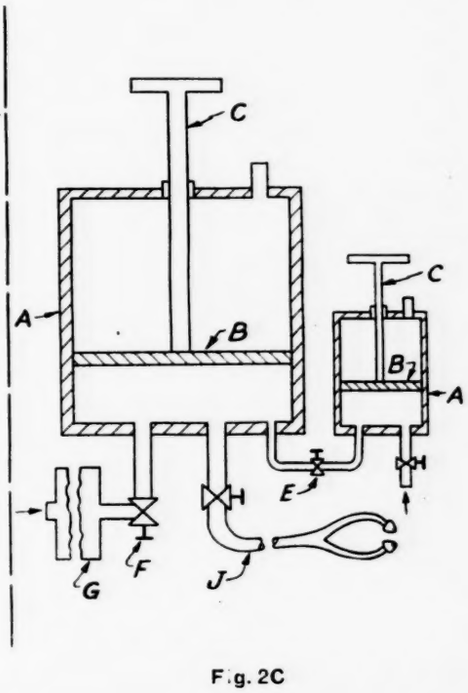


Fig. 2C

TABLE 2.—THRESHOLD ODOR CONCENTRATIONS IN PARTS PER MILLION

Substance	Threshold Concentration	Substance	Threshold Concentration
Artificial Musk	.0000065	N-butyl sulfide	.015
Crotyl mercaptan	.00012	Bromacetophenone	.015
Allyl sulfide	.00014	Chloracetephenone	.016
Ethyl mercaptan	.00026	Allyl isocyanide	.018
Thiophenol	.00026	Skatol	.019
Ethyl selenomercaptan	.00030	Methyl sulfide (Comm.)	.027
Diphenyl sulfide	.00034	Dithio ethylene glycol	.031
Isoamyl mercaptan	.00043	Benzyl chloride	.040
Diphenyl ether	.0010	Methyl mercaptan	.041
Phenyl isocyanide	.0010	Benzaldehyde	.042
Allyl disulfide	.0012	N-butyl mercaptan	.048
Ethyl selenide	.0012	Crotonaldehyde	.062
Allyl mercaptan	.0015	Acetaldehyde	.066
N-propyl mercaptan	.0016	Phenyl isothiocyanate	.094
Dichlorethyl sulfide	.0023	Hydrogen sulfide	.13
Benzyl mercaptan	.0026	Allyl isothiocyanate	.15
P-thiocresol	.0027	Propargyl aldehyde	.16
Ethyl sulfide	.0028	Amylene (Mixed isomers)	.19
Isoamyl sulfide	.0030	Pyridine	.23
Coumarin	.0033	Methyl thiocyanate	.25
Isoamyl acetate	.0033	Alpha butylene	.92
O-chlorphenol	.0036	Gamma butylene	1.3
Methyl sulfide	.0037	Allyl alcohol	1.4
Dimethyl trithio-carbonate	.0058	Ethyl isothiocyanate	1.7
Benzyl sulfide	.0060	Acrolein	1.8
Isoamyl isovalerate	.0066	Nitrobenzene	1.9
Methyl anthranylate	.0094	Beta butylene	2.1
N-propyl sulfide	.011	Crotonaldehyde (Comm.)	3.5
		Allyl amine	6.2

Concentration to produce Odor intensity 1 (Very Faint) on scale of Table 1. Where different tests of same substance were reported, the lowest concentration reported is used in this table.

sample is diluted and mixed, it is injected through hose *J* into a special nose piece fitted into the mask. These pieces are so shaped as to project a high velocity air stream toward the olfactory buds at the base of the nose and are touched to the nose by pressure from the front of the mask only when a test stream is being injected through them. Injection can be accomplished either by rapid hand pump action or by using a spring to actuate the pump. It should be obvious that injection hose *J* must be as short and of as small bore as possible in order to minimize dilution of injected air by air in the hose.

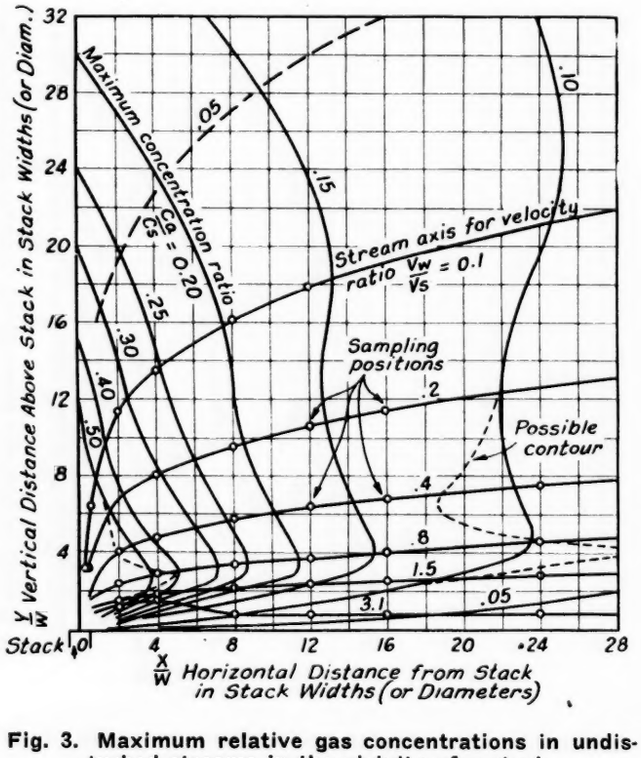


Fig. 3. Maximum relative gas concentrations in undisturbed streams in the vicinity of a stack.

Odor Fatigue

Whether or not an osmoscope is used, check observations are required by any one observer, but, of even more importance, several different observers should always check each other. This is necessary because of the subjective nature of odor and the variability of threshold sensitivity among different observers. Observers whose determinations vary too far from the norm of other observers must be disqualified from this type of testing. Prior to the start of the first observation of each series, the observer must spend a considerable period of time masked and breathing odor free air and he must remain thus during the entire period covering all successive observations at decreasing dilution. This is necessary because exposure to an undiluted odor for even a short period of time will decrease sensitivity to this odor to an unpredictable extent. This phenomenon is familiar to all of us in that we frequently smell a weak odor on entering a room which, after remaining in the room for a while, ceases to register even though the odor actually remains. What happens, of course, is that our odor sense becomes fatigued. This fatiguing also occurs when we are first subjected to a strong and then to a weak concentration of the same odorous material. Because of exposure to the strong odor, the nose becomes insensitive to the lower concentration. This, naturally, must be avoided in threshold odor measurement technique.

Odor Description

Occasions may arise when a ventilating engineer may be called upon not only to measure the intensity of an odor but also to record its character. This might come about, for instance, if it were proposed to control an odor nuisance not by reducing its intensity but by changing its character to one less objectionable or by masking it by a pleasant odor. In order to measure odor character or type several objective scales have been devised. These scales do not attempt to measure the extent to which an odor is objectionable or pleasant, but merely try to offer a means by which the degree of similarity or difference between odors may be recorded. The observer must have a well trained sense of smell and be able to recognize by memory the basic odor sensations comprising the particular classification employed. The observer must also be able to analyze mentally a complex odor into these basic sensations and to weigh their relative predominance in the observed odor using an arbitrary numerical scale.

Several different series of basic sensations have been proposed for analyzing the odor and taste of

foodstuffs. Perhaps the most carefully worked out is that of Crocker and Henderson[6] in which 4 sensations, fragrant, acid, burnt, and caprylic (goaty), are each employed on a 0 to 8 scale. Thus, their symbol for the odor of acetic acid is 3803. This means three degrees of a possible eight of fragrance, all eight of sourness (acid), no burnt sensation and three of a possible eight of goaty odor. This system has had no real test as yet in solving ventilation or atmospheric pollution problems, but there is no reason why it should not be as successful here as in the description and recording of food odors.

Odor Control in the Atmosphere

The ventilating engineer may be called in to solve one of two general types of odor problems. The first is to prevent the discharge of an odor from a factory or plant. Perhaps the surest way to solve this type of odor problem is to identify the malodorous substance. Once this is discovered, the conditions which give rise to it should be sought and then, if possible, these conditions so revised that the unsought reaction can no longer take place. In some instances, as in sewage treatment, there may be a biological condition requiring amendment rather than a chemical or physical one.

It sometimes happens that an impurity in a raw material causes the odor. The use of a more highly refined or purified raw material may, in this instance, solve the problem. When neither of these approaches is successful, collection by exhaust ventilation of the odorous effluent, and subsequent treatment of the exhaust to remove the olfactory component, is indicated as the next approach. Treatment may take the form of either (1) reacting the effluent in a reaction tower with a chemical or catalyst so chosen that the resulting reaction product, if gaseous, is nonodorous, (2) scrubbing the odorous component out of the exhaust gases in a scrubbing tower so as to form a liquid or solid end product, or (3) adsorbing the odorous component by means of activated carbon, or similar substance.

One specific means that has been used industrially is to discharge the odorous effluent into the boiler furnace or its stack so that some or all of the odor bodies may be oxidized or changed by temperature to a less odorous form. Another is to pass the effluent through a furnace in which sulfur is burned in an effort either to react with the odor bodies, mask the effluent with SO_2, or both. Treatment of the effluent with chlorine has also been tried for the same reasons. Passing the effluent through a condenser has been used to trap condensable odorous vapors, and electrical precipitators used to remove odorous liquid mists. In lieu of treating the effluent, discharge by means of a high stack may sometimes be used.

One particular outdoor odor source which is sufficiently widespread to warrant special mention is the internal combustion engine. The odor from engines is a problem both in the air of cities and in motor vehicles, particularly buses. The odor of exhaust appears to be proportional to its aldehyde content, being irritant and easily recognizable at aldehyde concentrations of over 10 ppm. The more nauseating portion of these exhaust gases may be still more complex than the aldehydes and contain some of the sulfur of the fuel. The solution to this problem is first and foremost one of engine design, maintenance and operation and of proper fuel specification to reduce odor emission, and only secondly, one of ventilation to prevent exhaust gases entering the car.

Odor Control in Buildings

The second type of odor problem that must be met by the ventilating engineer is the supply of odor free air to buildings when the outside makeup air is odorous. Under these circumstances, common sense dictates a maximum of recirculation and a minimum of make-up air. Under these conditions both recirculating and make-up air should preferably be passed through either scrubbers or adsorbers to remove odor. It should be noted that air washers using fouled water may add to rather than help solve an odor problem.

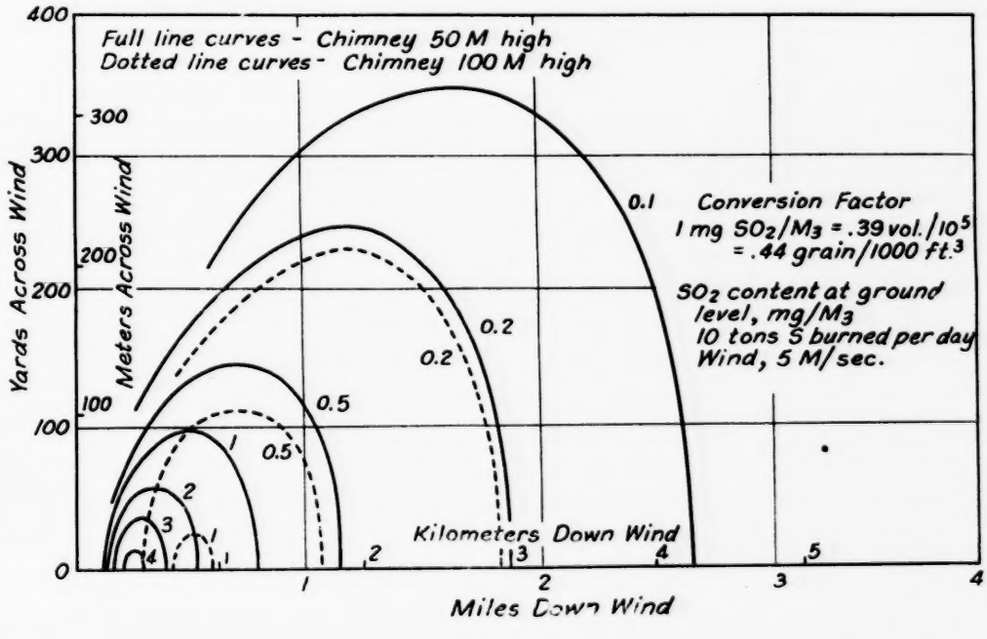
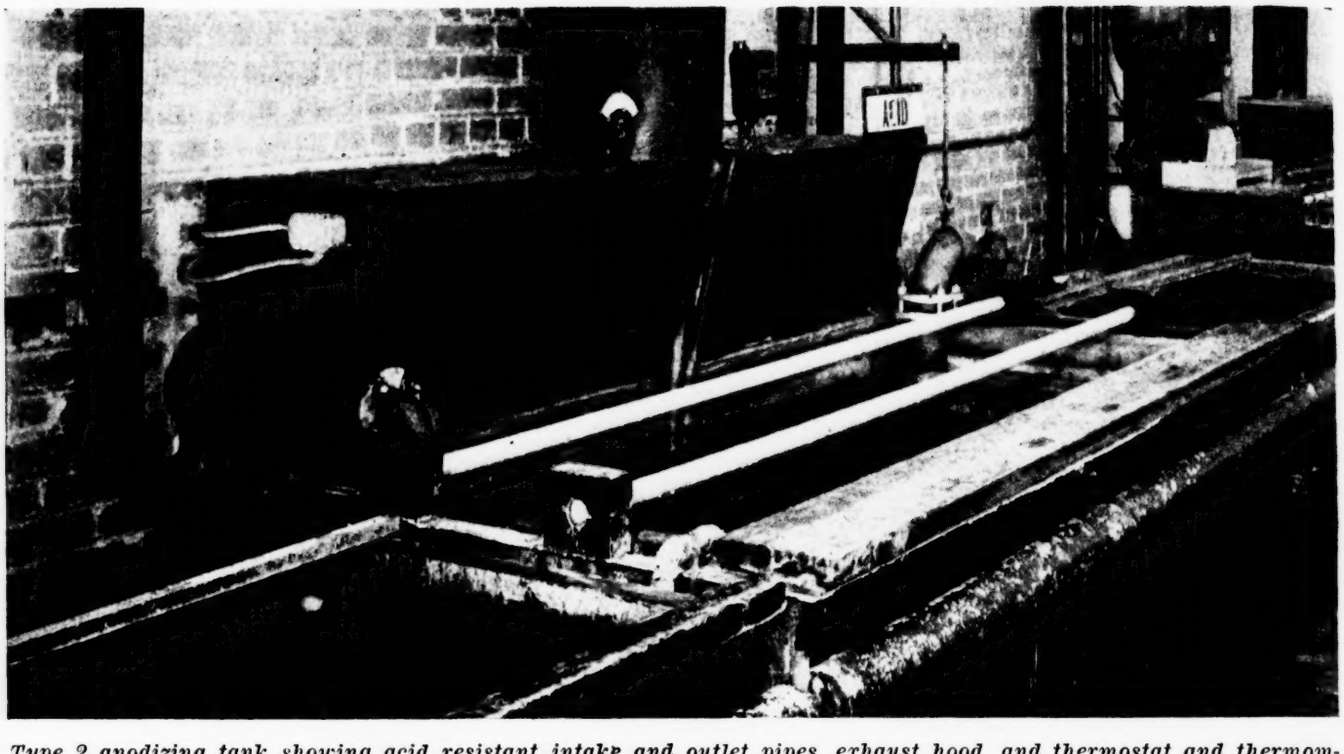


Fig. 4. Ground concentration distribution of SO_2 from chimneys of different heights.

[6]Crocker, E. C., and Henderson, L. F., Analysis and Classification of Odors, American Perfumer, Vol. 22, No. 6, August 1927.



Type 2 anodizing tank showing acid resistant intake and outlet pipes, exhaust hood, and thermostat and thermometer lead pipe wells. Cleaning and rinse tanks on either side.

Cooling Anodizing and Electroplating Baths

J. PARTINGTON, Jr.
Industrial, Contractor and Marine Sales Division, General Electric Co.

ANODIZING is an electrolytic process used to produce an oxide film on aluminum and aluminum alloys. This protective film, in addition to its corrosion and abrasion-resistant properties, forms a strong bond for paint primer. Proper control of current density and bath temperature produces an oxide film approximately 0.0001 in. in thickness on the parts being treated.

Chiefly due to the tremendous expansion of the aircraft industry, electric installations to supply power to anodizing baths have been in great demand. There has likewise been a great expansion in the market for cooling equipment to cool these anodizing baths.

The chromic acid process is the method generally used for most aircraft parts, although other acid solutions can be used for the electrolyte in certain anodizing processes. Some features of this method are low power consumption, low current density, low operating cost, and simplicity of bath control.

Chromic Acid Process

Briefly the process entails immersing the material in a tank holding a soap solution to clean it preparatory to being anodized. Thorough cleansing is necessary in order to secure a uniform coating.

The material, after cleansing, is lifted from the soap solution, and allowed to drain before being lowered into the anodizing tank. There it is immersed in an electrolyte, an acid solution of the proper specific gravity. In the tank, the material is suspended from busbars which become one electrode. The tank itself forms the other side of the electrical circuit. After a period of treatment of all surfaces at 40 volts for at least 30 minutes, in accordance with Navy specifications, the material is removed from the anodizing tank and lowered into a rinse tank. After this, it is placed in racks to dry.

Direct current produced usually by a motor-generator set, is used in the anodizing process. In one method, an attempt is made to vary the voltage so that the current density at the load is held relatively constant (usually at about 3 amp per sq ft).

Cooling Required

Since a considerable amount of heat is generated in the tank during the anodizing process, means must be employed to remove the heat or the electrolyte

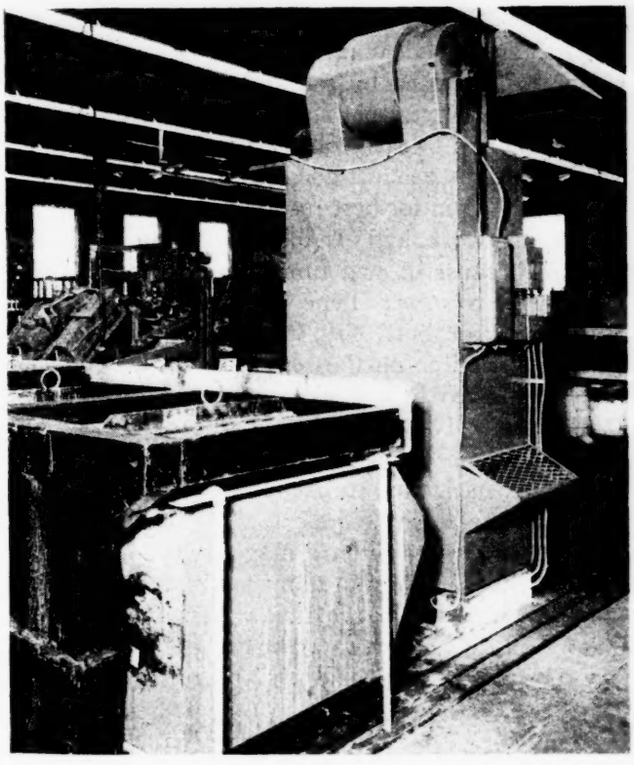
temperature will rise. With a tank of a given size, the amount of material which can be anodized at the proper steady temperature depends upon the cooling facilities available and the efficiency of heat transfer. The latter is a function of the design of the tank.

An insulating jacket of cork or similar material (a thickness of 2 in. is usually sufficient) is advisable to reduce the cooling required during the summer months. The insulation must be protected against moisture as its value decreases rapidly when wetted. With the chromic acid process, tank temperatures should be maintained at approximately 90F. Where a sulphuric acid solution is used for the electrolyte, tank temperatures of approximately 70F are required for best results.

Cooling Means

Water, when available at 50F from a well, is the cheapest method of cooling. It will often pay to sink a well, if cool enough water is available, since the same water can be reused in the rinse tanks. However, there are few spots in the United States where 50F water can be obtained from wells consistently the year round.

Mechanical refrigeration is a sure means of providing proper, controlled tank temperatures. A direct expansion system is not advisable, however, because of the dangers attendant upon acid leaks into the refrigeration equipment. Therefore, some form of heat exchanger is usually employed. Such an indirect system, employing chilled water as the cooling medium, has the further advantage of being operable on well or city water when low winter water temperatures exist.



Electroplating tank showing fume exhaust, tank and evaporative cooler insulated from the ground to prevent stray circuits.

Types of Systems

There are four types of indirect cooling systems in use:

1. Type which utilizes cooling coils mounted on the inside walls of the tank, and which employs compressed air to agitate the electrolyte.
2. Type which makes use of an external heat exchanger through which the electrolyte is circulated by means of an acid resistant pump. Compressed air is used to produce agitation in the tank as in Type 1.
3. Type which has a heat exchanger incorporated within the tank structure itself. A propellor type agitator, mounted in a well at one end of the tank, effects agitation of the electrolyte as well as circulating it over cooling coils located under a false bottom in the tank. Chilled water is circulated through the coils.
4. Type which employs a cooling jacket surrounding the tank. Cooling water circulates through the space between the inner and outer tanks, entering at the bottom and leaving at the top from the opposite side. Agitation of the electrolyte is accomplished by compressed air.

Merits of Each System

System 1 is relatively inexpensive to install and operate. It is limited in capacity by the amount of cooling coil which the tank can accommodate. Also, because of the relatively slow circulation of electrolyte across the cooling coils, the overall coefficient of heat transfer is comparatively low.

System 2 is efficient and in use in several plants. Good heat transfer is obtained through positive circulation of electrolyte. Chilled acid can be distributed to a particular point or points in the tank. Increased production for a given size of tank is possible since the cooling system takes up practically no space inside the tank.

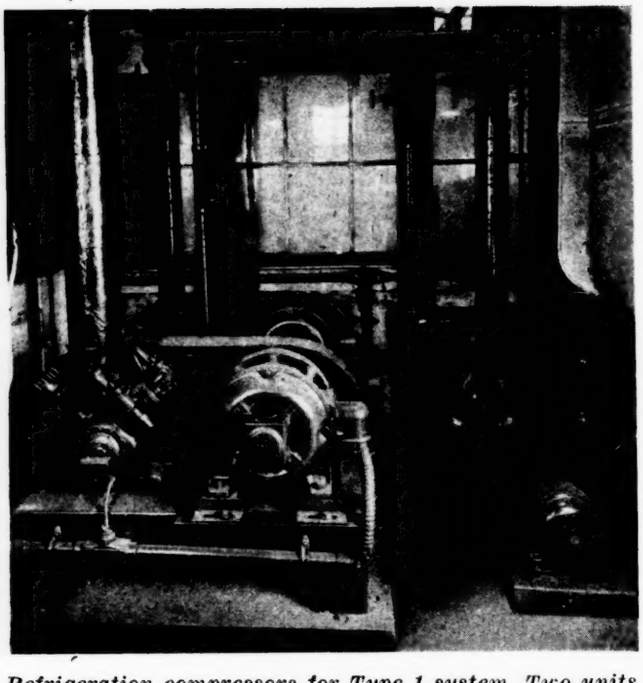
The chief feature of System 3 lies in the mechanical agitation of the electrolyte. This method of agitation is usually less expensive to operate than that using compressed air.

System 4 is economical of space and is applicable to certain small installations. The overall heat transfer coefficient is not high, so the cooling is only moderately efficient.

Design of a Cooling System

Let us confine our discussion from now on to Type 1 and Type 2 since they have greater merit and wider application. The first step in designing any system is to determine the heat load to be removed. It will usually be sufficient to consider the heat load as the equivalent of the electrical input to the tank. This can be determined quickly from the formula:

Watts (amperes $\times$ volts) $\times$ 3.41 = Load in Btu per hour.



Refrigeration compressors for Type 1 system. Two units were used to permit greater flexibility of control.

After calculating the load, the availability of 50F water during all, or a major part of the year, will determine largely the selection of the proper system.

Type (1) System: To determine the number of lineal feet of lead pipe required for Type (1) system, use the formula:

$$\text{Lineal Feet} = \frac{\text{Heatload in Btu per hour}}{\text{Sq ft per linear ft x temperature difference x coefficient}}$$

The A.S.R.E. Data Book gives the following coefficients of heat transfer for bare pipe in water bath, no agitation of bath, water circulated inside pipe at various velocities:

LEAD TUBE	
Coefficient in Btu per Sq Ft per Hr per Deg. F.	Velocity in Tube in Ft per Min.
38	100
40	125
41	150
42	200
42.5	250
43	300

The number of square feet of surface per linear foot of tube of various diameters is as follows:

I. D.-in.	Outside Diam. Tube-in.	Area per Lin. Ft in Sq Ft
½"	0.762	0.199
¾"	1.01	0.262
1"	1.364	0.357

The choice of a water velocity inside the lead tube is determined usually by the pressure drop encountered. A high pressure drop increases the size of the pump motor and pump operating costs. The choice of tube size is determined by the number of lineal feet of tube which can be installed in the tank without wasting too much space at the tank corners due to bends. The larger the tube, the larger the bending radius required.

Example: Water temperature = 50F
Tank Temperature = 72F.
Heat load = 400 amps. × 40 volts × 3.41 = 54,560 Btu per hour.

$$\text{Lineal ft} = \frac{54{,}560}{.262 \times 22 \times 42} = 225.4 \text{ feet of 1.01 O.D. lead tubing}$$

Type (2) System: To determine the size of the acid-to-chilled-water heat exchanger, the simplest and safest method is to consult the manufacturer's ratings. The Type (2) System, illustrated, required two 66 x 12 in. acid resistant heat exchangers, connected in parallel, each having 14 sq ft of surface. The load was 180,000 Btu per hour, the tank temperature was 70F, and the chilled water temperature was maintained at 40F. This gives an apparent heat transfer coefficient of 214 for this application. Such a coefficient is the result of rapid circulation of electrolyte through the heat exchanger, 50 gpm in this case.

The chilled water was provided by a twenty horsepower condensing unit connected to a 12¾ in. x 108 in. water chiller. The condensing unit was selected to operate at a 20F suction temperature under maximum load conditions and with 75F condenser cooling water.

The rubber hose connection in the cooled acid discharge line from the heat exchanger is necessary as an electrical insulator. A similar insulator is provided in the intake acid line.

An immersion thermostat, with its bulb enclosed in an oil filled lead pipe well, located on the rear center wall of the anodizing tank, controls the operation of the condensing unit to maintain a constant 70F electrolyte temperature. The other lead pipe well holds the bulb of a dial type indicating thermometer.

An exhaust hood at the rear of the tank removes the fumes generated by the anodizing process. Approximately 200 cfm per square foot of tank surface area is required to carry off the fumes. The entrance velocity into the exhaust openings should be approximately 2,000 fpm for best results. The exhaust hood, exhaust ductwork, and exhaust fan should all be acid resistant because of acid fumes.

Type (1) System: Type (1) System, illustrated, is arranged for both city water and chilled water cooling, depending on the season of the year. Pipe coils are located in a bank around the inside walls of the tank. They are spaced approximately one inch away from the walls to permit gravity circulation. The individual tubes of the coil bank are spaced about 1½ in. apart.

A wooden grating of hard maple or cypress is used to protect the tubes from damage, as well as to prevent short circuits in the tank. A rubber hose insulator in each chilled water line is also required for the protection of the operators and to prevent stray leakage of current.

Cooling of Zincplating Baths

Electroplating is an older and better known electrolytic process than anodizing. It is used to deposit

a protective film of zinc, cadmium, chrome, etc., on steel or other metal parts either for rust prevention or to improve the appearance of the finished article.

The higher current densities used in zincplating tanks today, as a result of increased production demands, make the provision of electrolyte cooling necessary. Normal heat loss from the plating tank is no longer adequate to prevent excessive electrolyte temperatures.

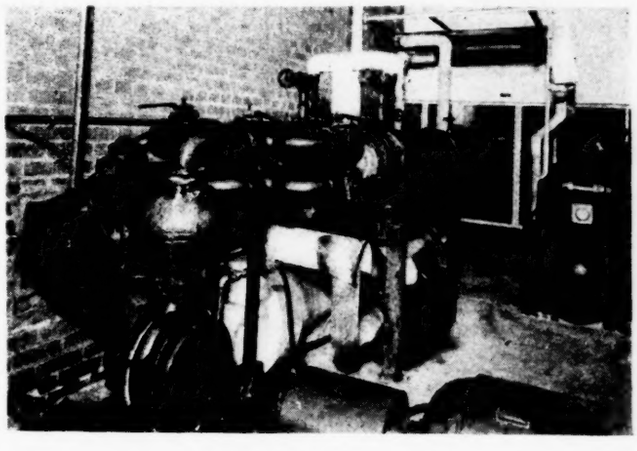
Reasons for Cooling

Excessively high electrolyte temperatures, even if they do not lower the quality of the plating, are conducive to high operating cost. In zincplating, for example, the warmer the electrolyte, the higher the ratio of cyanide to zinc that is required. And since the more cyanide there is in the solution, the faster the solution deteriorates (due to transformation into sodium carbonate because of the carbon dioxide present in the air), operating costs tend to rise because cyanide is expensive. Further, excessive sodium carbonate produces poor plating quality as well as making its removal necessary at more frequent intervals.

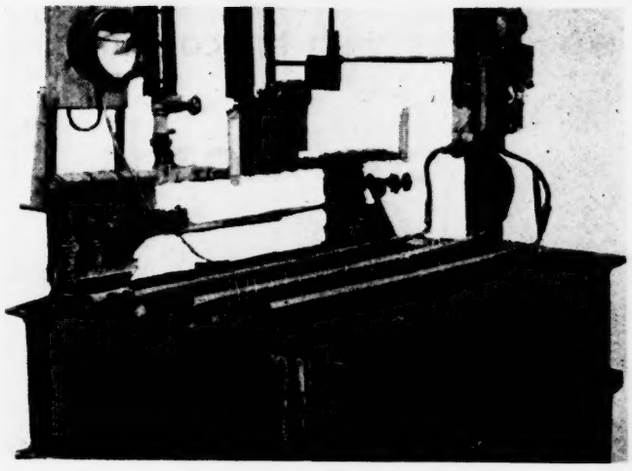
Methods Employed

Since satisfactory plating can be performed with electrolyte temperatures as high as 110F, cooling can be accomplished by means of city water in most localities. However, city water is not always cheap or plentiful and some other means of cooling is indicated. An evaporative cooler can handle those installations in which electrolyte temperatures no lower than 90F produce satisfactory plating. The chief advantage of an evaporative cooler is its low water consumption. A heat removal of 240,000 Btu per hour is possible with a water consumption of only one gallon per minute by the evaporative cooler.

Where electrolyte temperatures of 70 to 80F are required, mechanical refrigeration merits serious consideration, as is true in the case of anodizing, and much the same sort of equipment is necessary. Since this has already been covered, only a description of an evaporatively cooled system will be given here.



Type 2 system showing the refrigerator unit connected to the chiller. Chilled water is pumped through the acid resistant heat exchanger. An acid pump circulates the electrolyte.



Manifold of a Type 1 system tank to which are connected chilled and city water supply lines.

Typical Installation

The electrical input totalled 53 kw. The desired electrolyte temperature was 105F. The design outdoor wet bulb temperature was 78F. An evaporative cooler having a one hp fan, which circulates 2,850 cfm of air, and a ¼ hp spray pump was installed next to the plating tanks (see illustrations). The cooler handles 35 gpm of electrolyte, cooling it from 110 to 100F. The water consumption under peak loads is one gpm and the power consumption is 1.2 kw. An additional pump is required to circulate the electrolyte from the tank through the cooler and back to the tank. Only a small pump is required, since the pressure drop through the cooler is 2 lb per sq in.

While the evaporative cooler normally takes its air from outdoors and discharges it back outside the building, the installation shown here did not require ducts because the entire plating room is ventilated (the air being changed 40 times per hour).

The cooler should have steel tubes (no dissimilar metals should be used in the electrolyte circuit) and the pump should be entirely of cast iron. The cooler and electrolyte pump should be electrically insulated by rubber hose connections in the inter-connecting piping. These insulators should be at least 18 in. long to prevent leakage of current. The evaporative cooler itself should be insulated from the ground for the same reason.

The evaporative cooler could also be installed to take air from the building and exhaust it outside, thereby supplementing existing ventilation facilities. In winter, it could serve as an auxiliary heater and humidifier by discharging into the plating room.

This discussion has covered but a few examples of the way in which industrial cooling equipment has kept pace with the demands placed upon it by industry during the past few years. It should offer a solution for some of the problems of improved quality control in the future.

Experiences with air conditioning as related to

Room Loads, Filters and Servicing

E. L. SCHULZ
Engineer, Carrier Corp., Syracuse, N. Y.

The accumulation of experiences of several companies in various parts of the country regarding excessive room loads, filters, and servicing agreements and policies.

IT is customary, when estimating the normal air conditioning system, to have the prospective purchaser provide information on the estimated room loads. In this manner there is specified so many watts of lighting, so many people, so much motor horsepower with appropriate load factor, as well as a figure for the steam load and product load in the spaces to be conditioned.

In those instances where changes in room load are a cause of inadequacy of the apparatus, the source of trouble is obvious. Unfortunately, there are times when room loads exceed the original estimate and this increase in room load is not readily discernible. Infrequently, a customer does not fully appreciate the necessity of providing all the necessary data about the existing and proposed room loads. Unless he is impressed with need for such information, it is not possible to consider the load survey as complete. There are other cases where some condition prevails which escapes the eye of the inspecting engineer. One of the most frequent in this classification is the opening and closing of doors leading to the conditioned spaces.

It is extremely difficult to estimate the load imposed by opening and closing doors. The total load can, at best, be a guess involving the frequency of opening and the quantity of air infiltration with each opening.

On a job where even a small amount of air infiltration represents a large percent of the total room load, it is important that the frequency of door openings be carefully checked. In addition, every effort should be utilized to reduce the actual number of openings to a minimum. Numerous plans have been used to discourage excessive door opening.

In one case, employees within the conditioned space were the major offenders. In addition to their scheduled rest periods, there was a constant stream of workers who seemed deliberately to keep the doors in motion. In place of the calculated infiltration due to two openings per hour an actual check showed that the door was being opened just about twice each minute!

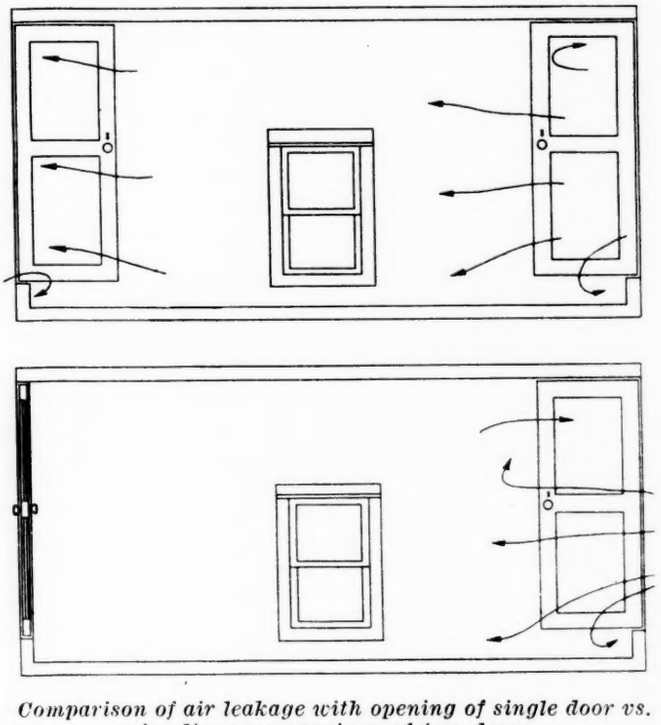
The trouble was overcome when the door was locked and the key placed in the care of the supervisor who worked within the conditioned space. As a word of caution—this scheme is feasible only if an auxiliary exit is available to eliminate a fire hazard.

In the second plant, the major offenders in opening doors were the employees located outside the conditioned spaces. The air conditioning system offered a comfortable haven during the summer and everyone seemed to "stop in" for a few minutes to cool off.

The solution to this problem was simple and inexpensive. Each employee within the room was provided with a white coat and cap. Any other employee with a legitimate reason for entering was temporarily provided with a white coat and hat. No one in ordinary work clothes was permitted to enter the conditioned space. Thus positive control of door openings was accomplished.

The amount of air infiltration resulting from the opening of a door is primarily a function of the number of doors opened simultaneously as well as the length of time that a door remains open.

Consider the case where more than one door provides access to the air conditioned space. There is



Comparison of air leakage with opening of single door vs. simultaneous openings of two doors.

always a heavy load imposed when two or more doors are opened at the same time. Due to the effects of cross circulation, the amount of infiltration air is usually greater than twice that resulting from the opening of only one door.

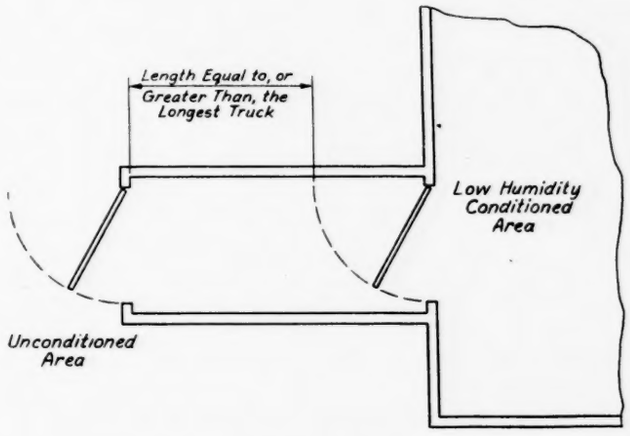
On certain installations, it has been possible to close off all but one of the access doors and eliminate the effects of cross circulation. Where conditions prohibit such a move, there is an alternate possibility of providing entrance vestibules at each door. This vestibule is designed to permit the closure of an outside auxiliary door before the room door is opened.

Another problem in preventing infiltration is created by lengthy door opening periods resulting from the passage of trucks or drays. Here again the construction of an entrance vestibule has proved its worth. However, in order to make this vestibule effective, its length should be sufficient to contain the entire truck with both doors closed. The use of the electric eye as a means of controlling door operation offers an excellent possibility.

Filters

It is common practice to consider the worth of a filter on the basis of the manufacturer's rating of dirt removal efficiency and dust holding capacity. However, items which also have an important bearing on the proper selection of a filter include first cost, replacement cost, maintenance, and the expected life of the filter. There are but few cases where the combined first cost and replacement or maintenance cost of a low priced filter can save money when compared with more expensive filters.

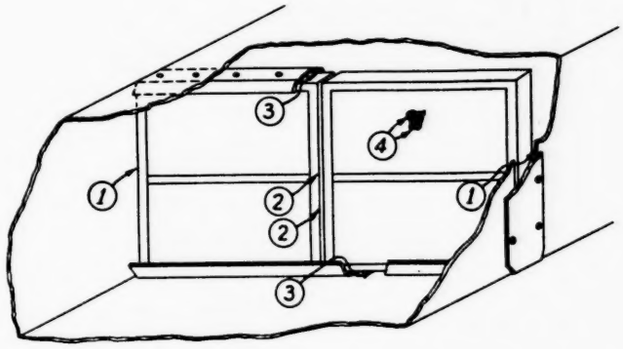
In spite of all the data available on efficiency of filters, it is still not uncommon to walk in on a job which has been operating for several years and to find that the owner has substituted a different grade of filter from that supplied with the apparatus. First cost of the filter seems to be the deciding factor in substituting an ordinary household furnace type of filter for the original industrial type of filter. However, it is possible to show that this false economy is hardly justifiable. Recently published data (Table 1) show by means of an intelligent and thorough analysis that the over-all owning and operating cost will vary considerably with different types of filters.



Double vestibule suitable for access to low humidity areas.

Doors should be metal or heavy wood. Common paneled wood doors are not suitable. Each door or door frame should be provided with refrigerator type gaskets. Glass windows in doors should be double or triple glazed, thoroughly caulked, if possible. Doors should be interlocked to prevent simultaneous openings. Walls, floor and ceiling of vestibule should be of the same vapor-proof construction as the walls, etc., of conditioned area.

One occasional source of failure of filters to perform efficiently is encountered in the slide frame type of filter holder which is installed in the air duct. In this type of application three or four, or more, filters will be placed in a continuous channel. Under normal conditions, this arrangement is perfectly satisfactory. However, there are times when there might as well be no filters in the duct. One case of this is where the channel frames are too large for the filters; for while there is always a small percentage of leakage present, this rate of leakage will increase as the resistance of filters increases with the accumulation of dirt.



Points of air leakage around filters and filter frames.

Usual points of leakage identified by numbers as—

1. End leakage around filters. Duct is too wide for tight enclosure of filters.
2. Leakage between filters. Correct by sealing with tape as filters are fed into frame.
3. Leakage through retainer channels in frame. Channels either improperly sized or bent out of shape.
4. Leakage through hole in filtering medium as a result of improper handling.

TABLE 1.—GENERAL CLASSIFICATION OF AIR FILTERS.

(From Modern Air Conditioning, Heating and Ventilating; Carrier, Cherne and Grant; Pitman, 1940. Chapter X.)

Type	Filtering Medium	Relative Efficiency	Relative Owning and Operating Costs
Dry—throwaway	Glass, paper, metal	7	4
Viscous—throwaway	Glass, metal	5	2
Dry—cleanable	Glass, paper, metal, felt	2	3
Viscous—cleanable	Glass, metal	4	1
Multiple centrifugal	Centrifugal velocity	6	5*
Continuous wetted	Metal or plastic plates or screens	3	7
Electrostatic	Electric precipitation on metal plates	1	6†

*Utilizes continuous blowoff of separated dust.
†Includes power used by power pack.

Even the most efficient filter sold today cannot possibly do a good filtering job if there is a bypass built around the filter, and essentially that is what this leakage is.

Another source of similar trouble is where the filter frame channel is properly designed and of suitable dimensions except that it is built of light gauge sheet metal. Only a few rough handlings of the filter frames in these panels will twist and warp the slides so that they no longer hold the filters in position. Such poorly built frames are bound to allow excessive leakage around the filters.

Servicing Agreements and Policies

It is indeed unfortunate that many engineering contractors completely forget a job after it has passed the warranty period. Little interest is shown in the servicing policy which may be adopted by the owner of the equipment.

Customer satisfaction is the cheapest form of advertising. When a customer tells his friends about the excellent air conditioning system he purchased from X Company, it is equivalent to hundreds of dollars invested in periodical and radio ads by that same X Company. But how can you expect that customer to talk in that manner if he feels that the X Company wanted to install the job and then to forget it?

When the contractor has his service department follow-up his installations with a definite service policy, he can be assured of a satisfied customer. If the organization does not include a service department, it is of advantage to establish relations with a reliable local service group and recommend them to the customer. Under any circumstances, the engineering contractor should set up a definite servicing policy as well as a procedure for emergency service work and place this information, in writing, in the hands of the owner.

An excellent example shows the difficulties that can arise in a customer's intent to approach the service problem blindly. When this customer experienced difficulty with his refrigeration equipment, he called in a service organization. The representative of the service organization looked at the compressor and decided that it was running with an insufficient quantity of oil and proceeded to add four quarts of oil to the crankcase. When this did not correct the conditions, the customer proceeded to call in a second servicing organization. This representative also analyzed the difficulty as a shortage of oil and proceeded to add four more quarts of oil to the crankcase. In each case the compressor picked up this oil from the crankcase and delivered it to the evaporator coil, where it collected in the distributor tubes of the coil.

Inasmuch as both of the service calls did not correct the condition, the customer, in final desperation, called upon the original contractor on the job. Upon first inspection of the crankcase it appeared that a slightly low oil level existed. However, there was evidence of violent boiling in the crankcase, indicating that a large quantity of oil and refrigerant were mixed. Further inspection revealed that the thermal expansion valve had lost its charge and thus was maintained in a fully open position. After the expansion valve was replaced, it was noticed that the dehumidification coil was frosting on some of the tubes, while other tubes remained absolutely dry. This evidence indicated that there was oil accumulated in the distributor tubes.

By the time the entire quantity of oil had been returned from the coil to the crankcase, a total of eight quarts of extra oil was removed from this crankcase, which, in the first place, only had a normal capacity of five quarts!

This customer was taught a lesson on the value of maintaining a contact with a reliable servicing organization, as well as the necessity of setting up a definite service policy with such an organization.

Another item of servicing which is often neglected is that of maintaining a policy of preventive servicing,—in other words, a policy of servicing equipment before failure has occurred.

This policy of avoidance of difficulties can, in every case, justify its cost. This does not necessarily mean that all equipment should be inspected and tested at the same time intervals, but it is a case of determining the reliability of the various pieces of apparatus and setting up a schedule of inspection for each of these pieces. After all, such a procedure is no different from the service policy encouraged by the automotive industry for car lubrications, motor tune-up, and so on.

The last of this group of five articles by Mr. Schulz on air conditioning experiences will appear in the December issue.

Reconversion to Oil Heat Urged

At a meeting of the New England Oil Heat Institute in Boston, Mass., October 18, the 200 dealers assembled were told by Executive Secretary Beckwith that OPA and PAW had sent assurance that those who had converted from oil to coal heat, could go back to oil if they wished. He estimated that if all the 200,000 reconversions possible in the New England area were made, that 6,000 to 8,000 barrels extra of oil daily would be required, but that supplies are ample to take care of this, while there is a serious coal shortage. A resolution was passed urging that apartment buildings, hotels and other users of bunker oil be allowed to draw extra oil rations up to their normal requirements.

CENTRAL STEAM HEATING for Large Building Groups

By P. A. CRONEY
Federal Public Service Authority

With an Introduction by [illegible]

EDITORS' INTRODUCTION

Heating of both private and public housing developments, as well as whole communities, by central plant steam distribution systems appears to be in position for considerable growth during the post-war period and, consequently, is entitled to an important place in this series of Blueprints of Post-War Realities. The wide diversity of possible applications makes difficult an approach to the subject applicable to all the numerous problems. Instead of attempting a too broad scope, Mr. Croney has been persuaded to outline and, in some cases, detail, information on heating for apartment type public housing projects with which he has had long and varied experience. His discussion is preceded by an introduction by the editors.

ANYONE familiar with the development of the art of heating in the United States might be puzzled as to why central (in the sense of *district*) heating should be considered in a series relating to post-war methods in which most of the subjects have been more or less new; it is quite true that there is nothing new in the idea of central heating plants. However, there are reasons why central, or district, heating seems to have widened its market potentialities during recent years so as to give this subject an import which formerly did not exist.

Distribution of steam to customers on a public utility basis began nearly seventy years ago, and the development of "street steam" utilities such as New York Steam Corporation, is well known. Similarly, the heating of more or less isolated groups of institutional, governmental and industrial buildings has developed to a point where the central plant is, in many cases, the only economical solution.

In attempting to set up a point-by-point analysis of why the outlook for central heating does appear favorable, one finds that so many variables are involved that it is not possible to discuss all of them. Further, there are insufficient data to develop all of the evidence to define all of these trends. Nevertheless, the paragraphs which follow cover some of these points, even if in a somewhat sketchy manner.

(1) The experience of the large housing projects built by the Federal Government beginning in 1933, and those of several insurance companies in recent years, has focused attention on the economy of central steam plants;

(2) Favorable experiences by both small municipalities and some real estate developments in central heating have attracted considerable interest. In neither of these groups generally has the question of franchise been too important (as it is in large cities), and in the case of private developments, central heating is an unusual and welcome sales argument;

(3) The long-time trend of fuel costs is upward, so that the efficiency of fuel generation, distribution and utilization becomes more and more a factor. The high efficiency of large modern boilers is well known and improvements in steam distribution have resulted from highly developed underground conduits;

(4) The public is increasingly conscious of air cleanliness and the desirability of smoke abatement. The central plant is one, if not the only, way to attain a reasonable degree of relief from the smoke nuisance;

(5) The tendency to decentralize industry, so marked during the war, has caused the building of enormous plants in relatively remote areas. Central heating in these plants is almost a matter of course and, as with housing, these developments have increased the prestige of this method of heating;

(6) Heating has developed from the fireplace stage to the central plant in the basement to the automatic plant in the house. Perhaps the next logical step is the automatic system using energy in the form of steam, gas or electricity generated off the premises. With the trend toward smaller houses, the space occupied by the heat generating unit (especially large in the case of warm air units) is relatively higher, so that the elimination of these units on the premises offers a space saving advantage.

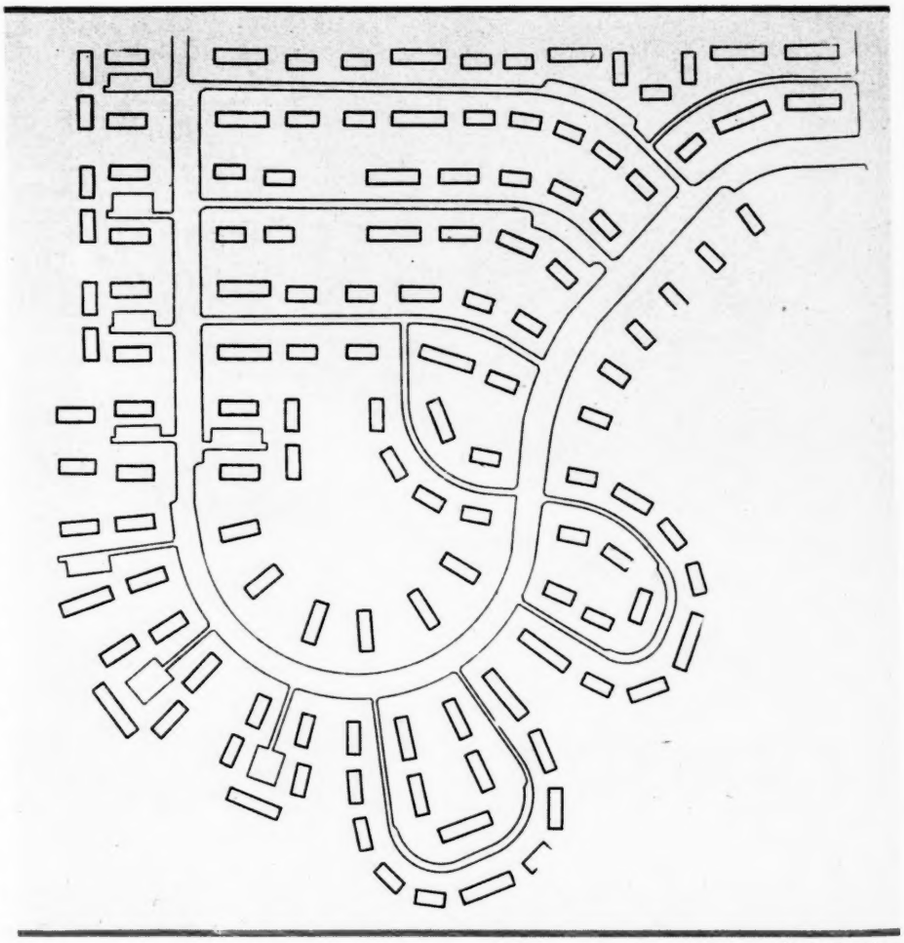


Fig. 1. A project with curved streets which results in a steam distribution system costing 25% over the design for a project with straight streets.

None of the foregoing points is as one-sided as stated; obviously there are counterbalancing arguments. It is equally obvious that it is impossible to evaluate the potency of the forces involved. They are included here to call attention to the possibilities of central steam heating systems in the post-war era.

The preliminary steps in promoting a central heating system for a municipality, for example, are sharply different from those involved in a real estate development or housing project. This difference is not so marked in the engineering of the projects, and for that reason it is believed that the article by Mr. Croney which follows will serve a useful purpose regardless of the exact form of the project.

Although central, as compared to group, plants are the subject of this section, the article includes information on group plants. The reason for this is that due to the importance of cost in any realistic program, the engineer will be well advised to have adequate knowledge of other methods; inevitably in discussions this matter will come up and when it does accurate data are far more impressive than guesses.

Design and Installation of Central Steam Heating Plants

By P. A. CRONEY

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In the early and middle 1930's the United States Government, through the Housing Division of the Public Works Administration, built at a cost of $125,000,000 some fifty large-scale projects for families in the lower income brackets. While this program was discontinued in favor of the present plan under which housing authorities in the local communities initiate, build, own and manage the projects, with federal loan and subsidy assistance, it provided valuable experience. The following data on mechanical equipment on several projects in this earlier program are typical.

HEATING PLANT DESIGN

In many cases the heating engineer is in the position of making the best of an existing layout. The project may be one already in existence. In other cases it is in the blueprint stage but for topography, orientation with respect to light, aesthetic or other reasons, the architects may have planned an arrangement of buildings which involve high costs in constructing the outside underground steam distribution system. For example, refer to Fig. 1 and Fig. 2. The curved streets in Fig. 1 result in a design which increase the first cost of outside utilities by as much as 25% over the design shown in Fig. 2.

It may be that the reasons for the curved streets will justify the increased cost of utilities, but this point should at least be called to the attention of the architects laying out the project.

In practically all cases there are important advantages and corresponding disadvantages connected with a given type of heating system, fuel, or arrangement of equipment and piping, with low overall annual operating expense as one of the ultimate objectives. Consequently, a very careful and detailed economic study of the principal schemes under consideration is recommended. Even where the tendency toward a certain system, arrangement or fuel is pronounced, such a study may bring out some startling facts and, if nothing else, supply a firm foundation for discussions and decisions.

It is not suggested that cost is the only consideration; however, it is certainly sound to have the costs carefully calculated so that the cost of the other considerations can be weighed. For example, smoke elimination may be involved; it is known that dirt and damage from smoke can be costly but the cost is difficult to determine. There may be, though, a cost for smoke elimination which is obviously over and above what is justified. The economic analysis will establish the facts on which to base the decision.

The economic heating analysis can be simply worked out by using the forms shown in Tables I to IV or similar forms. Table I covers the estimated capital cost of four different kinds of systems; Table II covers the estimated annual operating expense of each of the systems contemplated in Table I; Table III provides data on heating and Table IV helps in estimating the life expectancy of equipment, and gives multipliers which are applied against the capital investment, based on amortizing the capital investment over a period of 60 years.

Several suitable methods of heating should be tentatively selected and a comparative cost analysis made to determine which will result in the least expense to the tenant, as shelter rent will include heat and hot water. The underlying principles involved in this analysis are simple and require no explanation. There are certain common errors, however, concerning which a reminder may be helpful.

Perhaps the most prevalent mistake is to overlook items of expense

*Opinions expressed in this article are those of the writer and do not necessarily reflect the views of the FPHA; neither do they purport to predict any action that may be taken by the Government on any post-war housing.

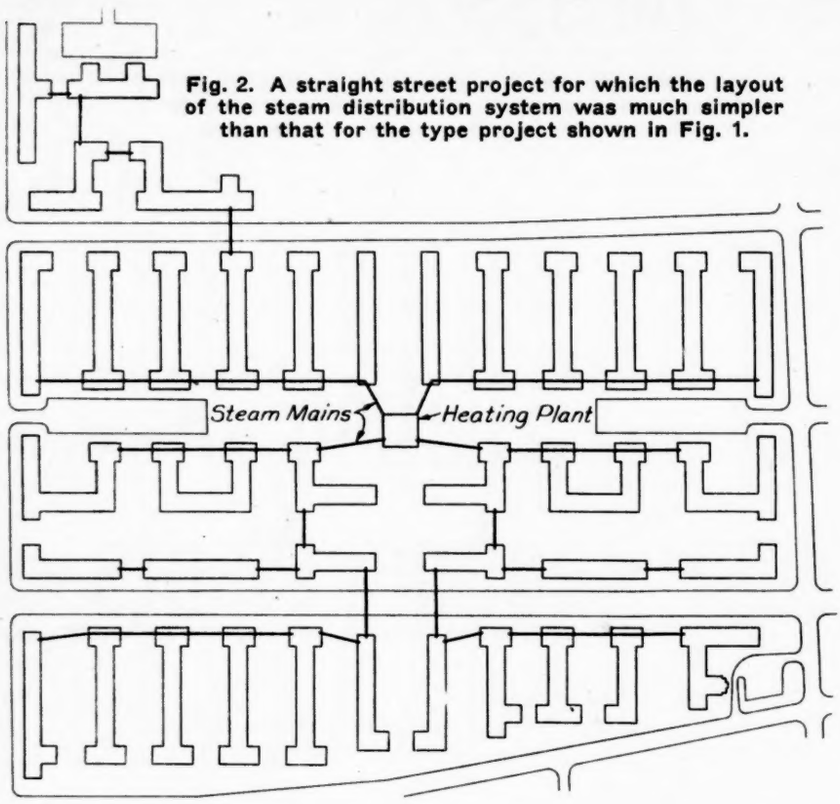


Fig. 2. A straight street project for which the layout of the steam distribution system was much simpler than that for the type project shown in Fig. 1.

which are indirectly involved in the use of a specific type of fuel or heating plant.

If group or central plants are being compared there should be included not only the costs of boilers, breeching, auxiliary equipment and piping, but also fuel storage, construction costs of boilers, storage rooms, smoke stack, and insulation of boiler room ceiling. In addition to this, consideration should be given to the cost of supply and return mains, with their supports, insulation and trenches or tunnels to nearby buildings and lines to hot water heaters as well as the extra cost involved in the preparation of the basement for the boiler plant.

The central plant should be charged with its building and chimneys, as well as complete steam distribution and return systems, and possibly the cost of land occupied if additional land has to be acquired to accommodate the central plant. In this connection another item to be considered is the cost of additional road to facilitate the handling of coal and ashes.

With respect to items such as maintenance and replacement, the expense for which may vary widely, the greatest care should be taken to avoid estimates which are either unfairly pessimistic or unduly optimistic.

The form in Table I provides for a central plant, group plants, or unit plants. The following explanation of the various items on this form will make clear just where the various costs are to be entered. The alphabetical letter prefex of each item appears on the various analysis charts.

Central or Group Plants. A. Radiation or unit heaters in buildings. Cost of the heating system within the buildings, exclusive of equipment, auxiliaries and piping within the boiler room. Radiation can be estimated by reference to Table III; however, this table is only for estimating boiler load, for heating only, line losses and hot water load to be added, and not for figuring room radiation.

B. Yard distribution. Cost of underground piping installation including excavation and back filling.

C. Plant equipment. Cost of equipment, auxiliaries and piping within the boiler room. Automatic firing and fuel handling equipment should be noted separately. Building plants might include one boiler room per building or one boiler room per two or three buildings.

Unit Plants. D-E-F-G. Cost of heating equipment for individual plants only. Items D, E, and F might apply to warm air system or circulators. Vents under D include fresh air connections. Items E, F and G apply to steam or hot water heating systems.

Heating—Related Items. H. Plumbing connections. Cost of water and drainage required for heating system.

I. Gas piping. Cost of proportionate share of gas piping applied to heating system where gas is the fuel.

J. Electric outlets. Cost of electrical work necessary for heating system.

K. Chimneys. Cost of masonry flues, stacks and foundations.

L. Structures. Cost of structures, additional to dwelling facilities, necessary to house boiler and auxiliary equipment for central or group plants.

M. Fuel storage. Cost of facilities for storing fuel. Fuel oil tanks concerned with the immediate operation of the plant or plants need not be included here.

N. Extra roads. Cost of extra roads required for the delivery of fuel or the removal of ashes.

O. Net initial cost (heating). Total of above items, each of which should include the sub-contractors' overhead and profit.

P. Gross heating cost. Net initial cost plus general contractor's added percentage.

Domestic Hot Water. Q to X (incl.). Costs of supplying domestic hot water. The same procedure should be followed as outlined heretofore for heating. It is necessary to note that when domestic hot water is supplied through generators deriving their source of heat from boilers used also for space heating, the cost of the extra boiler capacity and heating distribution should be included in items A, B and C.

Y. Gross cost (heating plus domestic hot water). The summation of items P and X.

Similarly, for Table II, covering annual operating expenses:

Heating and Domestic Hot Water. a through d. Maintenance, repair and replacement. The product derived by multiplying the initial costs from Table I by the factors set up for the respective items in Table IV. Related items generally refer to plumbing connections, gas piping and electric outlets.

e. Total of all maintenance, repair and replacement expense.

f. Fuel. Formulas have been prepared for estimating fuel consumption and appear later. The influence on the rate structure in the use of gas for space heating and domestic hot water in coordination with that required for cooking and refrigeration should be applied in the analysis. Where the electric consumption for the operation of auxiliary heating equipment is a substantial amount, its influence on the electric rate structure should be thoroughly considered.

g. Labor. In high pressure boiler plant operation it may be necessary to employ the services of a compe-

TABLE I.—ECONOMIC ANALYSIS OF INITIAL COSTS OF HEATING SYSTEMS.

PROJECT —— LOCATION —— STATUS ——
No. DWELLING UNITS —— HEATED CUBE —— DESIGN TEMP. —— No. BUILDINGS —— STORY —— COMPUTED BY —— DOCKET NO. ——
No. OF ROOMS —— CUBE PER ROOM —— DEGREE DAYS —— No. BUILDINGS —— STORY —— CHECKED BY —— SHEET NO. ——
ROOM RATIO —— No. BUILDINGS —— STORY —— DATE —— FROM —— TO ——

ITEMS, ARRANGEMENTS AND SCHEMES	METHOD A	METHOD B	METHOD C	METHOD D
Items				
Scheme: Heating				
Scheme: Domestic hot water				
Heating system—Number of plants				
Equivalent direct radiation: Heating				
Equivalent direct radiation: Domestic hot water				
Equivalent direct radiation: Total				
Total boiler horsepower				
Fuel: Heating				
Fuel: Domestic hot water				
CENTRAL OR GROUP BUILDING PLANTS				
A. 1. Radiation and/or pipe in buildings				
2. Unit heaters, ducts, grilles				
B. Distribution (yard)				
1. Intermediate pressure				
2. Low pressure				
C. Plant equipment				
1. Boilers, pumps, auxiliaries				
2. Fuel firing				
3. Fuel handling				
UNIT PLANTS				
D. Ducts, grilles and vents				
E. Radiation and pipe				
F. Heater or furnace				
G. Controls				
HEATING—RELATED ITEMS				
H. Plumbing connections				
I. Gas piping				
1. In buildings				
2. Outside buildings				
J. Electric outlets				
K. Chimneys				
L. Structures				
1. Separate building				
2. Basement construction				
3. Closets, partitions, etc.				
M. Fuel storage				
N. Extra roads				
O. Net initial cost, heating				
P. Gross heating cost (Item O + — %)*				
DOMESTIC HOT WATER				
Q. Heater and tank				
R. Generators and pumps				
S. Hot water piping				
T. Gas piping				
U. Electric outlets				
V. Chimneys or vents				
W. Net initial cost, domestic hot water				
X. Gross hot water cost (Item W + — %)*				
Y. Total gross cost, heating and water (Item P + Item X)				

*Percentage added includes general contractors' expense and profit.

tent first class licensed engineer. Local regulations may require such services continuously while the plant is in operation or for supervisory purposes only. In the latter case, a portion only of the engineer's time might be devoted to the plant. In any event, it might be advisable to charge full time services of second class licensed engineers.

In low pressure plant operation licensed men are generally not required unless stipulated by ordinance or labor organization.

When a plant or plants necessitate a twenty-four hour daily operation, the personnel per shift (with the exception of the chief engineer if permitted by regulation) can be multiplied by 3½ times, which should compensate for relief time. If, on the other hand, the plant or plants do not require operation on this basis, the staff could be reduced proportionately, with the necessary relief labor of approximately 16 2/3% per man added. It is advisable in preparing an analysis of different heating schemes before a selection is made, that only that portion of the firemen's time actually required in the operation of the plant need be applied to it.

Labor during the non-heating season can be reduced commensurate with the scheme of heating domestic

TABLE II.—ECONOMIC ANALYSIS OF ANNUAL OPERATING EXPENSES FOR HEATING SYSTEMS.

Items			Method A	Method B	Method C	Method D
	Scheme	Heating / Domestic hot water				
	System	Heating				
	Fuel and Price	Heating / Domestic hot water				
	Heat valve, Btu	Heating / Domestic hot water				
	Fuel Consumption	Heating / Domestic hot water				
	Electric Power, kw-hr	Heating / Domestic hot water				
	Efficiency of Fuel, as Fired	Heating / Domestic hot water				
HEATING						
a. Maintenance and repair						
1. Fuel firing and fuel handling: central or group building plants						
2. Other heating equipment: central or group building plants						
3. Unit plants						
4. Related items						
5. Structures						
b. Replacement						
1. Fuel firing and fuel handling: central or group building plants						
2. Other heating equipment: central or group building plants						
3. Unit plants						
4. Related items						
DOMESTIC HOT WATER						
c. Maintenance and repair						
1. Heater or generator						
2. Gas and water piping						
3. Related items						
d. Replacement						
1. Heater or generator						
2. Gas and water piping						
3. Related items						
HEATING AND DOMESTIC HOT WATER						
e. Total maintenance and repair and replacement (a to d incl.)						
f. Fuel						
Heating						
Domestic hot water						
g. Labor			—Chief —Mo. @ — —Men —Mo. @ — —Men —Mo. @ —	—Chief —Mo. @ — —Men —Mo. @ — —Men —Mo. @ —	—Chief —Mo. @ — —Men —Mo. @ — —Men —Mo. @ —	—Chief —Mo. @ — —Men —Mo. @ — —Men —Mo. @ —
1. Heating (plus — % insurance)						
2. Domestic hot water (plus — % insurance)						
h. Ash disposal						
i. Electric power						
j. Water and supplies						
k. Net annual operation (Item e through j)						
l. Net per room per year						
m. Net per room per month						
n. Debt service = (0.0017 + Y) Table I						
o. Gross annual operation (Item k + Item n)						
p. Gross per room per month						

hot water and the tenant requirements.

h. Ash disposal. Expense of removing the ash from the project. In some localities this may be arranged with the municipality at no expense to the project.

i. Electric power. Expense of electric energy for all electric motor driven equipment.

j. Water and supplies. Cost of water incidental to plant operation and supplies, such as waste and lubricating oil. On hot water jobs the make-up water should not be more than 1%, on gravity steam 15%, and on vacuum jobs not over 5%. All these percentages are based on new tight systems with the possibility of leaks that may be caused through neglect.

k. Net annual operation. The total of all operating expense (items e through j).

l. Net per room per year. The net annual operating cost (item k) divided by the number of rooms.

m. Net per room per month. The net monthly operating cost divided by the number of rooms.

n. Debt service. Multiply the gross cost of heating (item P) plus domestic hot water (item X) of Table I by 0.0017 (item n, Table II). The figure 0.0017 is the difference between 3.67% interest and amortization and the 3.5% annual subsidy. This is obviously assumed and applies only to Government housing projects. If the project is built by private capital, the debt service would be the product of Item P plus Item X multiplied by the interest rate; for example, if the interest rate is 3.5%, multiply by .0035 instead of 0.0017.

o. Gross annual operation. The summation of items k and n.

p. Gross per room per month. The gross monthly operating cost divided by the number of rooms.

Fuel Selection. Choice of fuel is dependent in a large measure on local availability and cost. Other considerations are cleanliness and

ease of handling. As the choice of fuel may affect the site plan and the management policy, an early fuel cost analysis should be made.

If four types of heating plants are figured for gross cost per room per month (p on Table II) and the overall difference is not more than 5% plus or minus, they can be considered equal and any one may be selected.

Design recommendations and suggestions for both central and group heating plants are presented in the material which follows. The central plant will be discussed first, then the group plants. The writer recognizes that there are various satisfactory methods of handling particular design features, and these suggestions are not to be considered the only acceptable ones. However, back of those ideas is experience gained in the design of over one hundred such projects, together with observation of the construction and operation of the projects.

TABLE III.—CUBIC FEET OF USABLE SPACE PER SQUARE FOOT OF EQUIVALENT DIRECT STEAM RADIATION*

Design Temp., F	Inside Temp., F	Temp. Diff., F	One Story Building	Two Story Building	Three Story Building	Four Story Building	Six Story Building
+20	70	50	48	61	67	71	75
+15	70	55	46	58	63	67	70
+10	70	60	44	54	60	63	66
+ 5	70	65	41	51	56	60	62
0	70	70	38	47	52	55	58
— 5	70	75	35	43	48	51	53
—10	70	80	32	41	44	47	49
—15	70	85	29	37	41	43	45
—20	70	90	26	33	37	39	42

*Figures in this table are for preliminary purposes only in preparing an economic analysis, and not for individual room calculations.

CENTRAL PLANT DESIGN

Boilers. Boilers should be designed to operate at 100 to 125 lb. per sq. in. gauge, with not less than three water tube boilers operating at 150% of rated capacity, or portable fire box boilers at 100% of rating. Normal rating should not exceed 500 hp except where more than four boilers are required.

Experience has shown that where three boilers are installed and operating at 150% of rated capacity, spare boilers are not required for possible breakdowns because of the following:

(a) The rating can be very easily increased when required from 150% to 225%;

(b) Peak load hardly ever occurs oftener than 1% of the heating season;

(c) Domestic hot water load can be reduced if necessary; and

(d) Repairs to boilers rarely ever require a shut down of more than half a day.

Boilers up to 100 hp can be of the firebox type; from 100 to 300 hp, either straight water-tube or low Sterling settings are recommended, while for boilers above 300 hp, either straight water-tube or high Sterling settings are suggested.

Insulation of settings on coal-burning boilers 300 hp and over will be improved by providing air-cooled walls. For oil or gas fuel, settings may have solid walls and air-cooled or water-cooled floors. For straight tube boilers, provide solid end and side walls 22 inches thick with full floating bridge-wall to take care of expansion. Provide for expansion in the setting walls as well as proper clearance between drums and settings

TABLE IV.—MAINTENANCE AND REPAIR REPLACEMENT FACTORS*

Scheme	Items	Maintenance and Repair: Under 300 Units	Maintenance and Repair: Over 300 Units	Replacement at 2% Interest	Expected Life in Years
A. Central plant, high-pressure steam or forced hot water	Fuel burning equipment and unit heaters[1]	0.0225	0.02	0.0412	20
	Other heating equipment	0.0225	0.02	0.0175	38
	Related items	0.0175	0.015	0.01	55
	Structures	0.0075	0.0075	—	—
B. Group plants or low-pressure steam or forced hot water central plants	Fuel burning equipment and unit heaters[1]	0.0225	0.02	0.0412	20
	Other heating equipment	0.0225	0.02	0.02	35
	Related items	0.0175	0.015	0.01	55
	Structures	0.005	0.005	—	—
C. Individual building plants	Fuel burning equipment and unit heaters[1]	0.0225	0.02	0.0412	20
	Other heating equipment	0.0225	0.02	0.0225	32
	Related items	0.0175	0.015	0.01	55
	Structures	0.005	0.005	—	—
D. Individual dwelling unit plant systems	Gravity warm air	0.02	0.02	0.0578	15
	Forced warm air, gas-fired	0.02	0.02	0.0209	20
	Gravity steam or hot water	0.02	0.02	0.0166	40
	Circulators	0.02	0.02	0.0913	10
	Structures	0.01	0.01	—	—
E. Domestic hot water	Heater and tank	0.0225	0.02	0.0578	15
	Generators; pumps	0.0225	0.02	0.0412	20
	Gas and water piping	0.0125	0.01	0.01	35
	Related items	0.0175	0.015	—	—

*The factors in this table are basic only; they may be varied to suit local conditions and type and quality of the heating or domestic hot water systems.

[1]Steam and hot water unit heaters. Gas-fired unit heaters are included in D.

TABLE 1.—CONSTRUCTION DATA ON FIVE PROJECTS CONSTRUCTED BY T

Location	Name of Project	Number of Buildings	Number of Apartments	Number of Rooms	Total Cubage, Cu. Ft.	Total Floor Area, Sq. Ft.
Detroit	Brewster	23	920	3129	9,500,000	782,000
Cleveland	West Side	44	620	2311	6,165,140	460,300
Boston	Old Harbor Village	34	1016	3912	6,942,000	771,000
Chicago	Julia C. Lathrop	31	975	3419	6,800,000	755,200 for living quarters; all other areas 269,140
Atlantic City	Stanley S. Homes Village	16	277	982	Living quarters, 1,731,820; all other areas 483,463	Living quarters, 192,424; all other areas 92,542

and supporting structural members. Support boilers independently of brick setting and building structures.

Provide for easy cleaning of all water and fire surfaces. Soot blowers on water-tube, horizontal return tubular, and fire-box boilers burning bituminous coal are desirable.

Water treatment facilities should be provided for all plants.

Easy removal of ashes should be provided for, as should a method for trapping and removal of fly ash.

A clear space of 14 ft, minimum (or as much as is necessary for pulling tubes), should be allowed between boiler fronts and the wall of the building, not less than 6 ft between the rear of the boilers and the wall of the building, and not less than 6 ft between each boiler for air- and water-cooled walls and 5 ft for all others. Each boiler should have an individual setting unless when set up in batteries of two.

Design for proper ventilation over the top of all boilers. This can best be accomplished by a monitor over each boiler with pivoted sash and extended operating device or by an installation of fans in ventilators.

Two doors should be placed in all boiler rooms, one large double door with small wicket door at one end of building and a 3 x 7 ft at the other end to facilitate escape in case of fire or large amounts of escaping steam.

Regardless of fuel selected, the boiler, breeching and chimney should be sized for hand-fired coal burning.

The experience of housing projects with the recent oil shortage prompts the foregoing statement. During and after the conversion of oil-burning plants the following points were noted:

(a) Due to congested boiler rooms many plants could not be converted without the expenditure of large sums of money for moving equipment and in some instances it was impossible to move the equipment;

(b) Some plants had to have induced draft-fans installed due to small chimneys and breechings that were designed for oil-burning;

(c) Other plants had boilers sized for oil-burning in the original design and during the period from December 15 to March 1 the boiler plants had to be operated twenty-four hours a day. Otherwise it would have been noon before a livable temperature could have been developed in the dwelling units;

(d) Lack of provision for contemplated coal storage in the original design made conversions to coal burning expensive; and

(e) With projects designed to amortize in sixty years anything can happen to curtail the use of a given fuel.

The steam outlet of each boiler, carrying in excess of 15 lb gauge pressure, should have an automatic stop and check valve at the boiler, and a globe or angle valve near the header. One or more flanged openings for future connections may be provided on boiler drums if desired.

Provide cat-walks with ladders so that all points on boilers which must be serviced may be reached, and furnish chains, brought to within 6 ft of the floor or cat-walk on all main overhead steam valves that cannot be reached from cat-walks or floors.

Chimneys. Peak boiler loads should be based on a selected minimum outside temperature. Chimney diameters should be the most economical size, calculated for peak load demand at 20F above the design temperature, with provisions for further extension if an extension to the project is anticipated in the near future.

Regardless of fuel selected, design the chimney for 90% excess air under peak load demand for coal, hand-fired, and with cinder trap.

Control of each boiler should be obtained independently through its own uptake damper. The main stack damper should be planned for hand control with locking equipment.

It is well to provide insertion points in the breeching at the stack for pyrometers for taking test temperatures.

Coal Storage. Overhead coal bunkers in central plants should be designed with a capacity of not less than thirty days' storage for the month of January. Where more storage is desirable, provide outside storage space for an additional thirty days' or more storage, protecting as desired to prevent theft.

In localities where the analysis of the coal shows a content of 3% or more of sulphur, overhead bunkers should be either of concrete, sectional cast iron or steel. If of steel, coat on the inside with at least ⅛ inch of bitumastic paint, or have a tile lining set in hot mastic. Breathing space should be provided around all over-head bunkers.

Divide bunkers into as many compartments as there are boilers.

BY THE HOUSING DIVISION, PUBLIC WORKS ADMINISTRATION.

Wall Construction	Height of Apartments	Boilers	Fuel	System of Heating	Radiation, Sq. Ft.	Hot Water, Gph (Raised to 125F)
Brick and tile	Three stories	Three 300 hp cross drum, straight water tube, operating at 125 lb gauge at 150% of rated capacity	Bituminous coal	2-pipe vacuum	94,947 cast iron 7,983 convectors 3,250 unit heaters 17,408 exposed risers	9,600
Brick and tile	Two and three stories	Three 250 hp cross drum, straight water tube, operating at 100 lb gauge at 150% of rated capacity	Bituminous coal	2-pipe vacuum	86,920 cast iron 8,685 convectors 9,378 unit heaters 5,092 exposed risers	7,500
Brick and tile	Two and three stories	Three 350 hp four drum, high sterling setting, operating at 150% of rated capacity	Bituminous coal	2-pipe vacuum	128,964 cast iron 2,408 convectors 3,000 unit heaters 7,111 exposed risers	12,500
Brick and tile	Three story apartments, three story flats and group houses	Three 370 hp four drum, air-cooled walls, high sterling setting, 125 lb pressure	Bituminous coal	2-pipe vacuum	157,091 cast iron 13,821 convectors 1,900 pipe coils 6,400 exposed risers	9,750
Brick and tile	Two and three stories	Three 150 hp horizontal return tubular	Bituminous coal	Forced hot water, 240F max.	37,843 cast iron 759 exposed risers	2,216

Coal and Ash Handling. Traveling weigh lorries, electrically operated, should have capacities of not less than 1,200 lb for boilers up to 250 hp and 1,800 lb for boilers above 250 hp, and should be equipped with switches to limit the horizontal travel. Electric motors for weigh lorries and other coal handling equipment should be explosion-proof, 40C type. Use of this type of equipment can be limited to projects where the total annual coal consumption exceeds 3,500 tons. Chutes to stoker hoppers should be closed on all four sides to protect against coal dust.

Where the rails for the traveling lorries pass close to the front of boilers, hinged sections should be provided so that they can be swung out, thus providing space for the opening of tube doors for cleaning.

When the annual coal consumption is up to 2,000 tons, consideration should be given to the method of ash disposal, and when over 2,000 tons, a pneumatic or preferably a mechanical system of ash handling is desirable.

Where cinder traps are used, pro-

TABLE 2.—HEATING DATA FOR FIVE PUBLIC HOUSING PROJECTS.

Item	Toledo	Buffalo	Youngstown	New York City	New York City
Construction cost	$167,000	$258,300	$215,118	$479,000	$528,928
Number of dwelling units	384	696	618	2,621	2,583
Number of rooms	1,602	2,756	2,466	10,780	10,657
Heated cubage, cu ft	2,467,080	4,417,667	3,994,920	15,797,303	16,198,640
Cubage per room, cu ft	1,540	1,603	1,620	1,465	1,520
Standing radiation, sq ft	51,609	85,500	87,400	187,763	272,714
Surface radiation, sq ft	5,734	25,500	23,500	45,623	11,000
Total equivalent direct radiation, sq ft	57,343	111,000	110,900	233,386	283,714
Service hot water, equivalent sq ft	21,120	34,800	33,990	144,155	141,500
Line losses (5%)	2,867	5,550	5,500	11,600	14,187
Number of radiators	1,886	3,358	2,706	7,810	7,794
Number of convectors	0	0	0	0	0
Number of unit heaters	8	0	0	0	0
Number of rooms riser heated	1,040	1,245	1,165	5,424	4,822
Radiation per dwelling unit, sq ft	149	160	180	88	110
Radiation per room, sq ft (average)	36	40	45	22	28
Total boiler load, equivalent sq ft	81,330	151,350	150,390	389,141	439,401
Boiler capacity, calculated, boiler hp	581	1,081	1,074	2,700	2,960
Boiler capacity, installed, boiler hp	450	988	—	2,791	3,416
Number of boiler plants	1	8	—	5	7
Number of boilers	3	16	—	15	28
Normal degree days per year	6,077	6,822	6,012	5,347	5,347
Design temperature, F	0	0	—5	0	0
Type of heating system	High pressure, central plant, two-pipe vacuum	Low pressure, group plants, two-pipe vacuum	Low pressure, purchased steam, two-pipe vacuum	Low pressure, group plants, two-pipe vacuum	Low pressure, group plants, two-pipe vacuum
Pumps, number	2 condensate 2 boiler feed 5 vacuum	8 condensate, 8 vacuum	13 vacuum	17 condensate, 17 vacuum 5 boiler feed	52 vacuum
Cost per sq ft radiation	$2.91	$2.33	$1.94	$1.91	$1.86
Cost per radiator installed	89.00	77.00	79.00	61.30	68.00
Cost per dwelling unit	435.00	371.00	348.00	183.00	205.00
Cost per room	104.00	93.70	87.00	44.44	50.00
Cost per 100 cu ft of building	6.77	5.85	5.40	3.00	3.30

TABLE 3.—FUEL FACTORS FOR USE IN ESTIMATING COAL OR COKE CONSUMPTION FOR STEAM HEATING.

Heating Value, Btu per Lb	Design Temperature, F						
	−20	−10	−5	0	+5	+10	+20
	Fuel Factor, Lb per Sq Ft Radiation per Deg. Day at 100% Eff.						
11,000	.00678	.00764	.00813	.00872	.00938	.01018	.01222
11,500	.00648	.0073	.0078	.00835	.00899	.00975	.0117
12,000	.00622	.007	.00746	.008	.00862	.00933	.0112
12,500	.00596	.00672	.00716	.00767	.00826	.00896	.01075
13,000	.00574	.00646	.00689	.00738	.00795	.00862	.01034
13,500	.00562	.00622	.00664	.00712	.00767	.0083	.00996
14,000	.00532	.006	.00639	.00685	.00737	.0080	.0096
14,500	.00514	.00578	.00617	.00662	.00712	.00772	.00926

vide for disposal of fly ash through the ash handling system. Dispose of the fly ash from the rear hopper of the boiler through the ash handling system or return to the stoker hopper for burning the combustibles.

Instruments. The following instrument boards are recommended for heating plants burning in excess of 2,500 tons annually:

(a) One main instrument board located in the boiler room as directed and having an electric clock, 6 inch diameter; smoke density indicator and recorder; recording and integrating steam flow meter, for yard distribution systems only; steam pressure gauge indicating boiler pressure; and a steam pressure gauge indicating pressure in the yard distribution system.

(b) An instrument board for each boiler, located adjacent to the boiler as directed and having: a CO_2 recorder; exit gas recording pyrometer; indicating and integrating steam flow meter; steam pressure gauge furnished under boiler trimmings; and draft gauge that will comply with the draft requirements by having the requisite number of pointers.

(c) Provide one year's supply of each chart used on each instrument board.

(d) Provide portable orsat.

Condensate Tanks. In all cases a condensate receiving or surge tank should be used, having a capacity of thirty-minute storage between overflow and automatic float controlling make-up water.

Where space conditions will not permit the use of a receiving tank, the feed water heater should have not less than thirty-minute storage capacity between the overflow and float valve make-up.

A cold water bypass should be arranged on the boiler feed pump suction for the purpose of boiler wash and for the operation of hydraulic tube cleaners. The pumps should be laid out to maintain feed water service to any boiler while another boiler is being given hydraulic service. Fig. 6 gives a suggested hook-up.

Boiler Feed Pumps. With an installed boiler capacity up to 400 hp, two pumps are recommended; from 401 to 1200 hp, three pumps are recommended, while for capacities over 1200 hp, special consideration should be given to the number of pumps.

No pump should have a capacity greater than 75% of the peak demand and all pumps should be steam driven. When three or more pumps are installed, one should be sized to take care of the summer load when operating normally.

Valve all equipment furnished in duplicate so that either or both may be operated singly or together.

Use feed water heaters of the deaerating type, operating at not less than 210F, with a reserve storage capacity of not less than five minutes between overflow and cold water make-up inlet.

Pressure Reducing Valves. Mount the primary pressure reducing valve assembly in a horizontal position on a side wall rather than in a horizontal position near a ceiling. Provide platforms for servicing if required. See Fig. 5. The arrangement shown in Fig. 5 is suggested for use when it is impossible to secure pilot operated pressure reducing valves for dead-end service.

Experience has shown that three or more pressure reducing valves, arranged so that one valve can take care of the entire hot water load in the summer, provide a flexible installation. As an example for calculation, the following may be used:

Assume a heating load of 12,520 lb of steam per hour, a hot water load of 4,550 lb of steam per hour, equal to 17,070 lb of steam per hour plus 10% for line losses, a total of 18,777 lb of steam per hour.

The pressure reducing valve to take care of the hot water load should be adequate for 4,550 lb of steam per hour, plus 10% line loss or a total of 5,000 lb of steam per hour. Subtracting this from 18,777 pounds of steam per hour leaves 13,777 pounds per hour; one valve can take care of 75% of this and the other takes care of the balance. By this arrangement the valves may be opened or closed to meet the increase or decrease of the demand steam load. In no case should these valves be larger than 8 inches.

If the secondary pressure is, say, 30 lb gauge, and three pressure reducing valves are used, one valve should be set for 30 lb gauge, another for 27 lb, and the third for 33 lb.

With these settings, when there is little demand for steam, all the valves will be shut off except the one

TABLE 4.—FUEL FACTORS FOR USE IN ESTIMATING GAS CONSUMPTION FOR STEAM HEATING

Heating Value, Btu per Cu Ft	Design Temperature						
	−20	−10	−5	0	+5	+10	+20
	Fuel Factor, Cu Ft per Sq Ft Radiation per Deg. Day at 100% Eff.						
500	.14933	.168	.179	.192	.2065	.224	.2688
1,000	.07466	.084	.0896	.096	.1033	.112	.1344
1,040	.07180	.08077	.0862	.0923	.0994	.10769	.12923

TABLE 5.—FUEL FACTORS FOR USE IN ESTIMATNG OIL CONSUMPTION FOR STEAM HEATING.

Heating Value, Btu per Gal.	Design Temperature						
	−20	−10	−5	0	+5	+10	+20
	Fuel Factor, Gal per Sq Ft Radiation per Deg. Day at 100% Eff.						
140,000	.000533	.0006	.00064	.0006857	.000737	.0008	.00096
148,000	.000505	.000568	.000606	.000649	.0007	.000757	.0009081

set for 33 lb. As the pressure decreases due to steam demand, the 30 lb valve will automatically go on and so on until all of the valves are open.

Pressure reducing valves should operate full open for the best results. Otherwise wire drawing will happen to valve seats and discs. Protect the secondary side of pressure reducing valve stations by a battery of pop safety valves having a capacity of 60% of the peak steam demand load.

TABLE 6. — FUEL FACTORS FOR USE IN ESTIMATING STEAM COMSUMPTION FOR HEATING.

Design Temp., F	Fuel Factor, Lb. Steam per Sq Ft Rad. per Deg. Day
—20	.0778
—10	.0875
— 5	.0933
0	.1000
+ 5	.1077
+10	.1167
+20	.1400

GROUP PLANT DESIGN

The group plant method is a compromise between the one central plant and the unit plant for each individual building; in other words, the project is divided into groups, each of which has its own plant.

The writer has never been able to reconcile himself to the use of group plants unless it is impossible to cross streets with heating lines due to underground structures, such as sewers and subways, or where right of way has been denied.

Group plants are not recommended unless necessitated by unforeseen difficulties. Group plants are usually preferable to individual building plants, although the latter may be practical for very large buildings. Group plants should be located to allow interconnection to insure flexibility under mild weather and summer load operation.

There is nothing economical about a group plant. The capital cost is usually more and the annual operating expense is always higher than the central plant.

Boilers. Boilers in group plants should be of the portable fire box type, sized at 100% of rated capacity. Each plant should have at least two boilers, with the capacity of each boiler not to exceed 25,000 square feet of direct radiation.

About the worst thing that can happen to a boiler plant design is to locate it in the basement of some building below grade unless, however, enough space has been allowed for the equipment (which seldom happens), with plenty of room to walk about and provision made for proper ventilating facilities.

For single or two pipe gravity steam heating systems, equip the boilers with regular Hartford loops and valved so that any or all boilers may be operated or drained without interruption of service.

Equip the steam outlet of each boiler carrying up to 15 lb gauge pressure with one globe valve in each connection.

Condensation. The idea that the boiler plant must be set low enough to return the water of condensation by gravity to the boiler plant is one of the greatest fallacies of plant design. Such a design causes many headaches while making the drawings, installing the system, and maintaining operation. One of the cheapest and simplest methods is to have a pump for about every six buildings and pump the water of condensation back to the boiler room.

Boiler Rooms. Where living or office quarters are located over boiler rooms, there should be a hung ceiling with a space of at least 12 inches between the ceiling and the floor slab above. Through this 12-inch space should be circulated air, taken from the boiler room floor at the rate of not less than one air change in every six minutes and discharged to the outside; otherwise the floor above will be too hot for the occupants. This circulation should be by a fan with a tail thermostat set in the 12 inch space above. Thermostat should be reverse acting and set to shut down when temperature in the space drops to 70F and start fan at 85F. The suspended ceiling can be built of metal lath, supporting any desirable insulation, and at the option of the owners be plastered over for finish.

Louvered openings should be provided in the outside walls of all boiler rooms to allow air for combustion.

Hot Water Generators. The advantages of locating boilers and hot water generator in the same building as against two or more hot water generators placed in machine rooms throughout the project are as follows:

(a) Hot water supply and recirculation can be placed in the conduit with the steam mains;

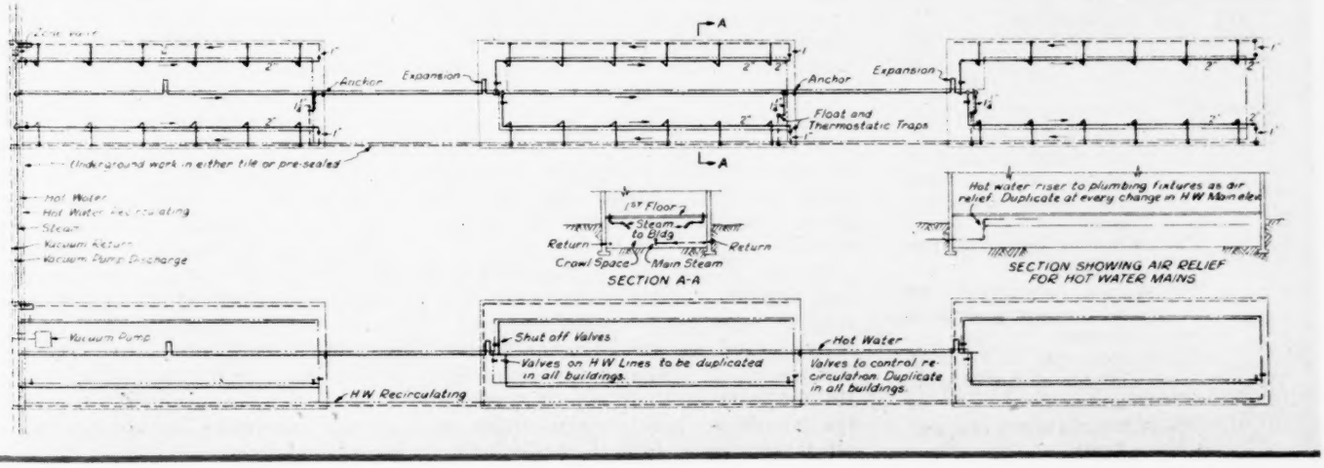


Fig. 3. A layout of a steam distribution system showing how the mains can be planned so as to eliminate the use of outside expansion pits.

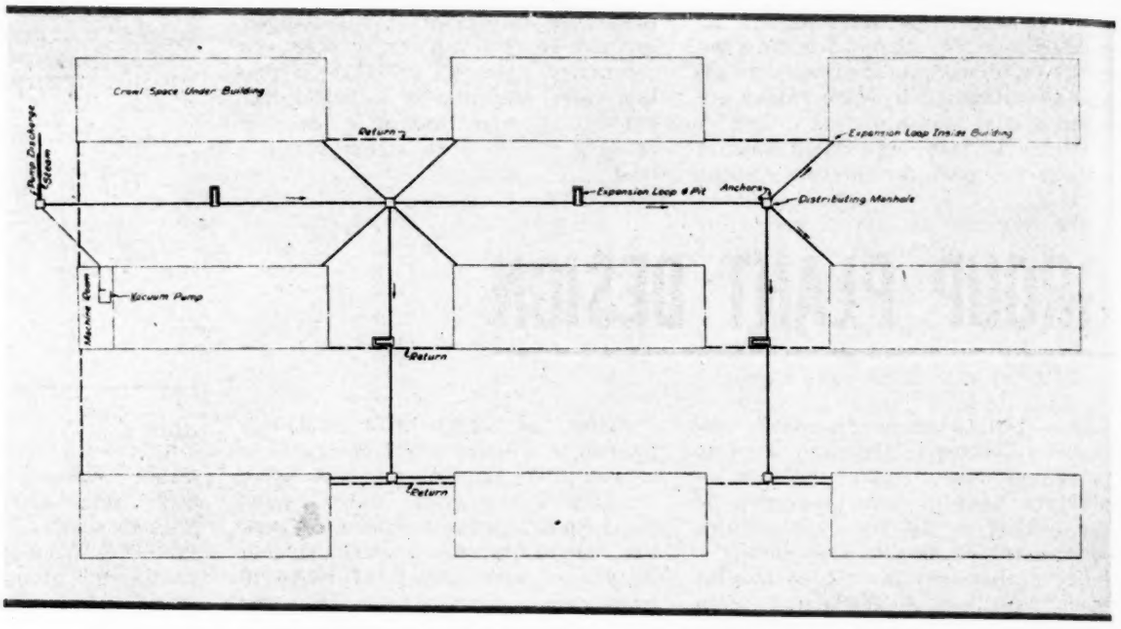


Fig. 4. A steam distribution system using outside expansion pits.

(b) In the off heating months there will not be any steam in the yard distribution system;
(c) The rate of line loss in steam mains with a 25% load is greater than with 100% load;
(d) There is less equipment and consequently less maintenance; and
(e) There is closer observation on the part of the operating engineer.

Pumps. Whenever possible, arrange group plants carrying up to 15 lb gauge pressure, so that the vacuum pumps can discharge water of condensation directly to the boilers. Where this is impractical use single stage motor driven boiler feed pumps, fed through a surge tank.

CENTRAL AND GROUP PLANTS

Hot Water Load. The steam load to be added to the boilers for generating the domestic hot water load can be calculated as follows:

Lb. steam per hour =

$$\frac{\text{D.U.} \times 8 \times 8.33 \times 100}{960} \times 1.05$$

where D.U. = number of dwelling units,
8 = allowable gallons of water in the tank for each dwelling unit,
8.33 = pounds of water per gallon,
960 = Btu absorbed by water per pound of steam,
5% = loss due to recirculation of hot water, and
100 = temperature rise per hour.

The foregoing will, in many cases, equal about 25% of the total equivalent direct radiation.

Scales. Where it is not possible to secure certified weights of coal deliveries, include motor truck scales of the beam type, installed in pits, if feasible. The scales should have a capacity of not less than 70,000 lb.

Laundry Drying. Construct clothes drying rooms in groups adjacent to laundries. When steam is used, the supply should be taken from the hot side of the zone control valve so that heat may be available during the summer season. When hot water is used, the unit heaters may be supplied from the basement hot water mains.

Drying rooms should have exhaust fans capable of exhausting to the outside at least ten changes per hour. When laundries are adjacent to drying rooms, the exhaust fans may get the majority of their supply through the laundries. Insulate the ceiling of all drying rooms to protect the rooms above from the heat of the drying rooms.

The foregoing types are not considered good practice due to the fact that steam must be kept on during the summer months and the certainty of quick drying is directly proportioned to the ability to get rid of the saturated air.

Consideration should be given to the installation of cabinet type dryers in lieu of drying rooms. The cabinet type of dryer, using either gas or electricity, requires much less basement space and substantially increases available laundry facilities through more rapid drying.

Controls. The purpose of the heating control system is to provide a heating system in which the circulation of steam will be equalized either by an adjustable orifice made as an integral part of the radiator valve or as a properly sized removable regulating plate in each radiator valve assembly. Any other means may be used which will insure receipt of steam by all radiators at the same time, proportionately.

Manual control should be provided to increase or decrease the heat flow variably, for producing continuous steam flow, and for shutting off the steam flow entirely, and means should be provided for automatically shutting off the steam flow when the outside temperature rises above 65F.

Each system should be balanced to synchronize the action of the several zones so as to produce an even load curve on the boiler plant. Demonstration should show this when the steam flow valve varies less than 20% (10% above and 10% below the average demand) in an interval of twenty minutes.

Furthermore, the control system must be capable of preventing overheating within the range of temperature of 75F to 68F.

Zone control valves should be located so that each valve will have about the same steam demand. The variation should not exceed ten percent (10%) and not more than six buildings should be placed on any one zone valve.

Operation. The heating system must be tight enough so that a 15 inch vacuum produced on a cold system will not be reduced to less than 10 inches within 60 minutes after the pump has been stopped.

The heating system must circulate noiselessly and each radiator must heat throughout to the trap with a pressure differential range of 2 inches to 6 inches of mercury between the points of steam supply and the return.

Heat Loss Calculations: Refer to the latest edition of the American Society of Heating and Ventilating Engineers' Code of Minimum Requirements of Heat for Buildings, using infiltration instead of allowance for north and west exposures.

As a matter of practical application the following inside temperatures may be figured:

Living quarters .....70F.
Sleeping quarters .....70F.
Kitchens .....67F.
Bathroom .....75F.

Because of the many variables involved in the calculation of heat losses through walls, ceilings, floors and glass, in localities where the design temperature is 0F to 70F the heat loss can be figured on the basis of +5F to 65F. However, the boiler size should be figured on the basis of a heat loss of 0F to 70F. This applies also to other design temperatures; for example, locations where the design temperature is —20F to 70F; here the boilers can be sized at these temperatures, and the radiation sized on the basis of —15F to 65F.

Costs. The installation costs of heating on five projects in Table 2 were compiled from actual contractors' costs on work done prior to 1940, but is fairly consistent with current prices.

Average cost per square foot of radiation for the five projects was $2.19; average cost for radiator installed was $74.84; average cost of heating per dwelling unit was $308.40; average cost of heating per room was $75.68; and average cost of heating per 100 cubic feet of heated area was $4.88.

DISTRIBUTION LINES

Design of the heating distribution system should not be deferred until after the site plan has become set. Both the character and extent of the distribution system may be influenced by close cooperation between the heating engineer and the site planner from the beginning. Buildings arranged compactly will achieve economy in heating distribution. Where plenty of land is available, it is more economical to concentrate the area not needed for housing in a single large unit than to space the build-

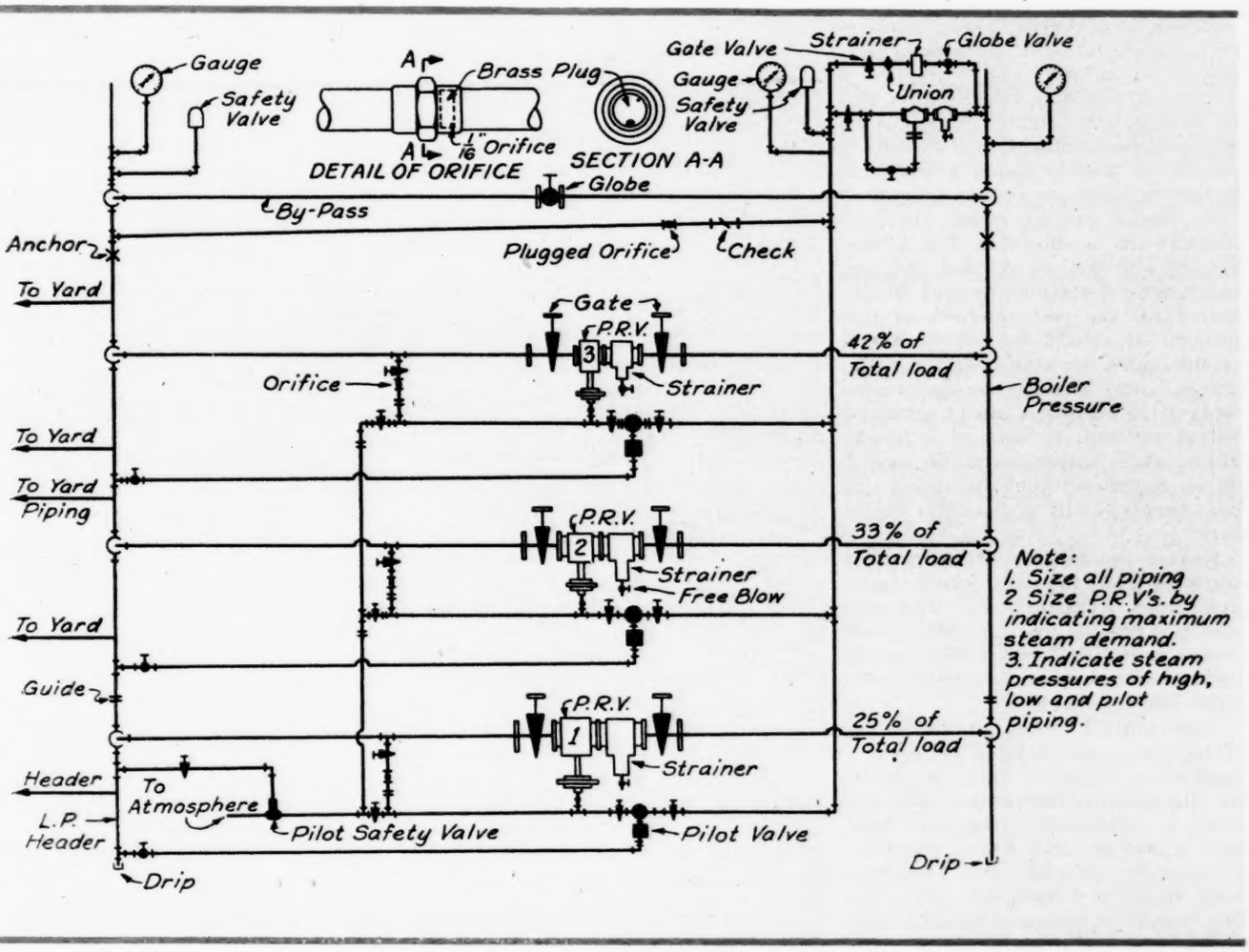


Fig. 5. Diagram showing reducing valve assembly suggested for use when it is impossible to secure pilot-operated pressure reducing valves for dead-end service.

ings widely over the entire site.

An investigation should be made of soil conditions for the bearing value before the design of any underground distribution system has been started. Particularly is this true when the project site is filled ground or on a city dump.

The writer has in mind one large housing project that was built on a city dump. The buildings and main sewer were built on caissons but the steam and hot water underground distribution systems were not. These lines settled so badly that some sheared off at the building. To remedy this situation it was necessary to employ an engineer familiar with soil values to prepare plans and specifications. The rebuilding of these lines will cost about $250,000, which could have been saved by the proper thought at the time of the initial design.

Underground steam and return distribution should be direct; design layouts so as to take care of expansion at the point of entrance into each building, where possible.

Refer to Fig. 2, and note that all steam mains enter the building basement or crawl space. This eliminates outside expansion pits, as the various mains requiring provision for expansion can be anchored in one building and expand into the building where the mains enter.

Fig. 3 shows how steam mains can be laid out to eliminate expensive outside expansion pits such as shown on Fig. 4, thereby doing away with unsightly manholes and maintenance.

By laying out the steam distribution system as shown in Fig. 3, the project site can be divided into as many control stations as may be required for the best interests of the project. It should be further noted in this same drawing that the main steam supply and the various mains feeding the buildings can be properly valved so that, in case of a breakdown, each building can be closed off for repairs without disrupting the heat supply to any of the other buildings.

Reduce the number of steam drip traps located in yard steam manholes to a minimum, and wherever possible provide for dripping yard steam mains by traps placed inside the nearest basement. If possible, keep traps out of manholes.

Underground piping should be installed in a simple type of conduit consisting either of split-tile, built-up tile, pre-cast lightweight concrete with a continuous concrete base and gravel backing where required, sponge-felt asbestos pipe covering with integral waterproof jacket, or of a system of presealed conduit with metal outside casing insulated with a sectional covering. However, all types of conduit should be given full consideration. All conduit installations should be specified to be substantially in accordance with the manufacturers' commercial standards, avoiding expensive pet ideas of the engineers.

Inside Piping. Supply and return risers should be exposed and arranged to serve two or more radiators on each floor wherever possible. However, if there is sufficient money in the capital cost, risers and radiators can be concealed. Arrange the connections for both supply and return on the same end of radiators at the end nearest the riser. Install radiator supply and return branches below floor in fireproof floor construction.

Install radiator supply and return lines between the floor and ceiling in wood joist floor construction, or on the ceiling below if desired. Floor joists may be notched near bearing for this purpose. All connections through floors, walls or partitions should have sleeves and escutcheons. Wherever possible use exposed risers for heating the kitchens and the bathrooms.

The amount of radiation for each radiator called for on the riser diagram or schedule should be the minimum required.

Risers, when exposed in rooms, should be considered as heating surface. Supply and return mains should pitch down and be free of pockets, sags or lifts throughout their entire run.

ESTIMATING FUEL CONSUMPTION

The principal item in annual operating expense is the cost of the fuel. The method used by the writer to estimate the fuel consumption for heating is to base this on the equivalent direct (steam) radiating surface together with unit fuel factors applied to the radiator surface and degree days. As used here equivalent direct radiation (EDR) is the total heating surface used for space heating, including all radiation, pipe coils,

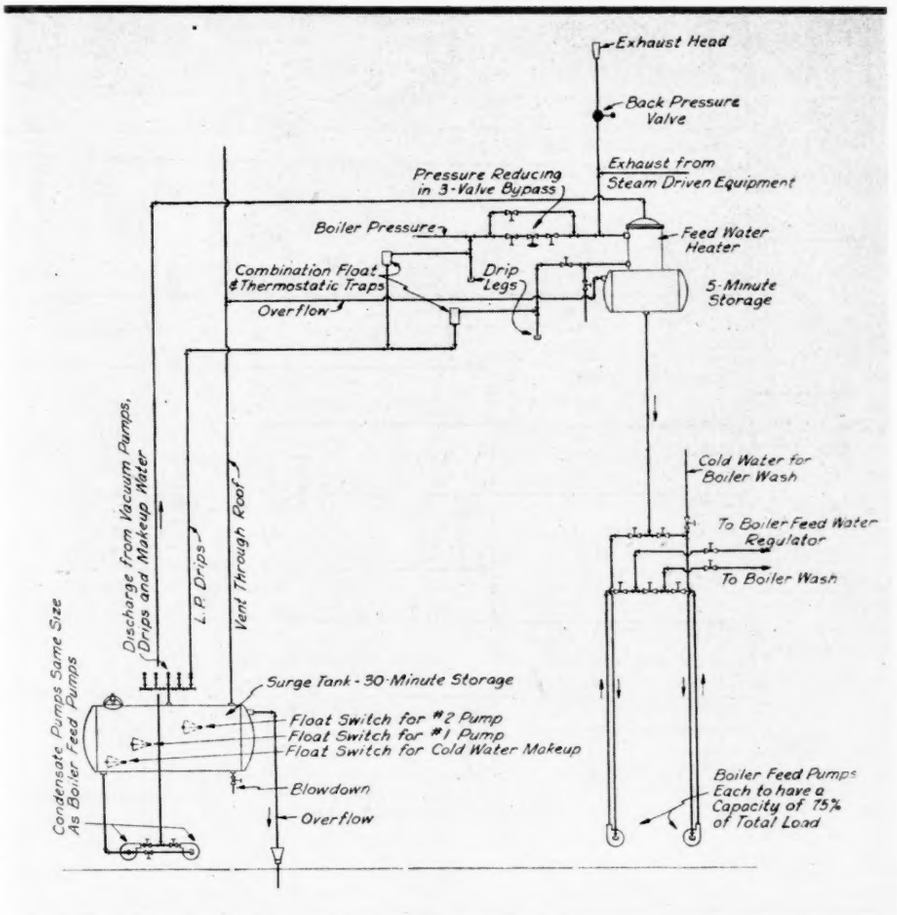

Exhaust Head
Back Pressure Valve
Exhaust from Steam Driven Equipment
Pressure Reducing in 3-Valve Bypass
Boiler Pressure
Feed Water Heater
Combination Float & Thermostatic Traps
Drip Legs
5-Minute Storage
Overflow
Cold Water for Boiler Wash
To Boiler Feed Water Regulator
To Boiler Wash
Discharge from Vacuum Pumps, Drips and Makeup Water
L.P. Drips
Vent Through Roof
Surge Tank - 30-Minute Storage
Float Switch for #2 Pump
Float Switch for #1 Pump
Float Switch for Cold Water Makeup
Blowdown
Overflow
Condensate Pumps Same Size As Boiler Feed Pumps
Boiler Feed Pumps Each to have a Capacity of 75% of Total Load

Fig. 6. Suggested hookup for feedwater heater and surge tank.

exposed risers, unit heaters, adjusted to EDR, including domestic hot water heating which is figured separately and added to the heating load. One square foot EDR is equal to a heat emission of 240 Btu per hour.

Basic Formulas: The following fuel formulas are based on a 24-hour-day operation. Deductions in fuel estimates should be made for night shutdown.

For coal,

$$\text{Tons per year} = \frac{\text{EDR} \times \text{Fuel Factor (Table 3)} \times \text{Annual Degree Days}}{2000 \times \text{Efficiency}}$$

For efficiencies in central or group plants the following are suggested. These may seem low, but through experience it has been found that year round efficiency generally averages these figures:

Hand firing 60%
Stoker-fired (low pressure)....65%
Stoker-fired (high pressure)..70%

The fuel factor is in terms of pounds of coal per square foot of equivalent radiation per degree day for corresponding design temperature and 100% efficiency, as given in Table 3.

For gas,

$$\text{Thousand cubic feet per year} = \frac{\text{EDR} \times \text{Fuel Factor (Table 4)} \times \text{Annual Degree Days}}{1000 \times \text{Efficiency}}$$

For gas the fuel factor is expressed as cubic feet of gas per square foot of radiation per degree day 100% efficiency, as given in Table 4. An efficiency of 75% is suggested for gas-fired plants.

For oil,

$$\text{Gallons per year} = \frac{\text{EDR} \times \text{Fuel Factor (Table 5)} \times \text{Annual Degree Days}}{\text{Efficiency}}$$

For oil the fuel factor is in gallons of oil per square foot of equivalent radiation per degree day 100% efficiency, as given in Table 5. An efficiency of 75% is suggested.

For Purchased steam,

$$\text{Thousand pounds per year} = \frac{\text{EDR} \times \text{Fuel Factor (Table 6)} \times \text{Annual Degree Days}}{1000}$$

In this case efficiency is assumed at 100% since there are no generating losses, and the fuel factors are from Table 6.

The foregoing formulas can be applied to individual building plants for space heating estimates. The individual building plant scheme can also include a boiler plant serving two or three small buildings. The following efficiencies are suggested for these *smaller* plants:

Hand-firing, bituminous coal..44%
Hand-firing, anthracite coal...52%
Stoker-fired, bituminous coal..50%
Stoker-fired, anthracite coal ..55%
Gas 70%
Oil 65%

Additions to Basic Formulas: For all space heating estimates based on continuous operation, 20% should be added to the fuel consumption if zone control is omitted. Twelve percent should be added to the fuel consumption to compensate for line losses in high pressure central plants and 10% in low pressure central or group plants.

If no zone control is provided 20% should be added where the design temperature is 0F or higher and 15% where the design temperature is less than 0F. Twelve percent should be added for line losses, if these losses are to be absorbed by the project.

Five percent should be added in preliminary calculations only to the fuel consumption to compensate for line losses in individual building plants.

Domestic Hot Water. For the heating of domestic hot water with steam coiled generators with an allowance of 60 gallons of water used per day per dwelling unit for 365 days per year, the following formulas are suggested:

$$\text{Coal. Tons per year} = \frac{\text{D.U.} \times 60 \times 1.1 \times 365 \times 960}{H_c \times .50 \times 2000}$$

$$\text{Gas. Thousand cu ft per year} = \frac{\text{D.U.} \times 60 \times 1.1 \times 365 \times 960}{H_g \times .50 \times 1000}$$

$$\text{Oil. Gallons per year} = \frac{\text{D.U.} \times 60 \times 1.1 \times 365 \times 960}{H_o \times .50}$$

where D.U. = number of dwelling units,
H_c = Btu per lb. of coal,

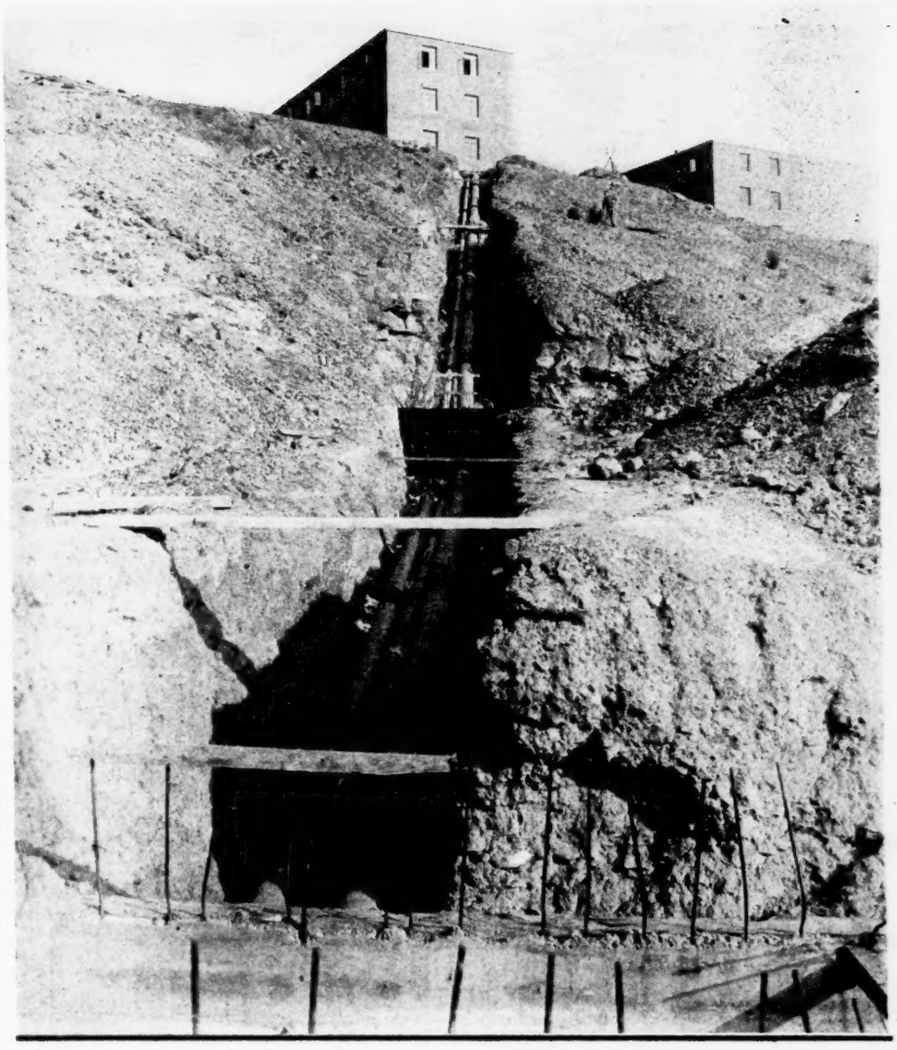


Fig. 7. Underground steam, trap discharge, and return pipe distribution lines extending to two of the 83 buildings in the Terrace Village housing group, Pittsburgh, Pa.

Fig. 8. Progress photograph of Terrace Village housing project, Pittsburgh, Pa., showing central heating plant which supplies high pressure steam to a total of 83 buildings.

H_g = Btu per cu ft of gas,
H_o = Btu per gal of oil,
60 = gallons of water per day per dwelling unit,
1.1 = lb of steam per gal of water,
960 = available Btu per lb of steam,
365 = days per year,
.50 = efficiency of utilization of fuel

Where the hot water generators are scattered in machine rooms throughout the project there should be added to the fuel consumption an amount to compensate for the loss of steam in the trench.

Where the hot water generators are located in the boiler plant it is recommended that 5% be added to the steam consumption as a safeguard against unforeseen losses.

Monthly Data: In the case of utility-supplied energy, such as gas or steam, the basic formulas can be used for a monthly period by using monthly degree days. This is necessary where the rates are computed on a monthly basis. The monthly costs are then totaled to obtain annual costs.

Some of the foregoing material has been taken from a design manual prepared by the writer for the United States Housing Authority in 1938 and brought up to date for present day practice.

Occupancy factors influence

Air Conditioning Installation Results

T. W. REYNOLDS

THE accompanying sketch of an actual air conditioning system for a well known general office space exemplifies how crowding brought on by wartime requirements can change former satisfactory air conditioning. Originally, occupants were grouped and lights were on only along the exposed walls. The relatively vast interior was occupied by storage of records. Eventually, files were removed, all space became crowded with personnel, and all lights were kept on. This built up a heat gain which even in the heating season could not be offset by heat loss from the small exposure of glass and rather heavy masonry walls.

As a result air had to be introduced at grilles at temperatures of 60F or less to pick up the heat gain and still maintain a 70F room temperature. Even in the heating season, quite often cooling rather than heating became necessary. To allow a warmer temperature of the entering air, it was finally decided to set the room thermostats at 74F. This permitted air to enter at 66F when it was zero degrees outdoors; entering air could be 62F with 64F outdoor temperature. The lower of the two temperatures was necessary due to the lesser heat loss with higher outdoor temperatures. This combination of overheating the room and underheating the air delivery was still a long way from satisfactory, so that absenteeism from colds, and inefficiency due to high room temperatures were the result. No matter where one sat there was a nearby grille.

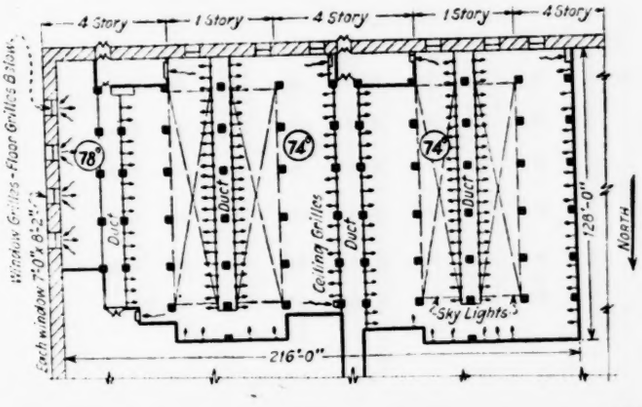
It is not an easy matter to introduce cold air into space by means of grilles with an 11½ ft ceiling, and at the same time avoid drafts. Circular air diffusers could be installed in the overhead ducts serving this space and the grilles closed off. Air would be diffused and raised in temperature by mixing with room temperature air before passing over room occupants. If found desirable, the volume of air circulated could be increased to give a corresponding increase to the entering air temperature. With grilles, the increased rate of air movement would probably be as drafty as less air circulation at lower temperatures.

Much of the heat gain in this office space came from the lights which were 500-watt each. Fluorescent lighting would have brought about a substantial reduction in heat gain, but the change would be rather expensive. It was found that by removing the paint on skylights (as formerly required because of blackout regulation) the required artificial light load was appreciably cut. Incidentally, the cost of removing the paint was higher than the cost of new skylights.

As shown in the sketch, some grilles were too much in line with very wide columns, so that the throw striking these columns projected it downwards on nearby occupants in a narrow stream of cold air. This condition came about, as it always does, because the draftsman while noting that there are columns, seldom visualizes the magnitude of these same columns when furred out. He usually calls for so many grilles of the same size along a duct run. Even had he spaced them with care, the contractor would have cut the duct at regular intervals for the insertion of the grilles. The window grilles discharged vertically upwards at high velocity along the glass and induced secondary or room air through wall grilles directly below near the floor.

Difficulties at this point followed because desks were located against the wall. Personnel at these desks, finding their feet in a draft on its way to the wall grilles, began to cover part of the window grilles with books or other material. This increased the high velocity vertical discharge and projected air down from the ceiling on their heads. Moral: never install horizontal window grilles.

The entire space, as sketched, has a floor area of 25,000 sq ft. Seven air changes of air per hour are circulated for the 275 occupants. The amount of outdoor air varies from a minimum of 25% up to 60% of the total air circulated, the minimum being for zero degrees outdoor temperature. This means the amount of outdoor air per person is a minimum of 30 cfm for only a very few days and a maximum of 72 cfm most of the time and that the cube of the space is changed with outdoor air from two to four times in an hour. In these respects the system is theoretically ideal and no complaint can be made, yet the system as a whole is far from ideal.



Oil Piping—Its Design and Application

HARRY D. UNWIN

Mechanical Engineer, Albert Kahn Associated Architects & Engineers, Inc.

Part 3 – Conclusion

Pipe Sizing Formulas

FLOW of oil in circular pipes is extremely complicated due to the fact that it depends upon the friction factor, specific gravity, viscosity, velocity, length of pipe, diameter, and pressure drop. Of these, the friction factor is the most important because it is a function of the nature of the flow in the pipe. Through research it has been proven that there are two types of flow—streamline and turbulent—which are in turn a function of the viscosity. Streamline flow occurs when the velocity of the oil is so slow that each particle moves parallel to the walls of the pipe, with those at the center moving progressively more rapidly than those adjacent to the pipe wall. When the velocity of flow increases beyond the "critical point," the flow becomes turbulent; that is, there no longer exists a uniform straightline flow, but an eddy-flow in which the oil particles, while continuing to flow in one general direction, are moving in an uncontrollable and disorderly manner. Experiments have conclusively shown that these currents are caused by the interior surface condition of the pipe. Although there is no short-cut for determining the friction factor or effect of the pipe surface on the character of flow, a great many studies have been made to show the relationship of the various factors involved and to check formulas with experimental data. As a result, there have been numerous charts and tables developed to aid in the determination of this all-important friction factor.

Fortunately, experimental work has shown, beyond reasonable doubt, that the fundamental Fanning equation for flow of oils, as well as other liquids, is more nearly correct than the majority of other fluid flow formulas. This formula for determining the pressure loss may be stated as follows:

$$p = \frac{0.323\, f\, s\, v^2\, L}{D} \qquad (1)$$

$$= \frac{0.0538\, f\, s\, L\, Q^2}{D^5} \qquad (2)$$

where p = pressure drop, lb per sq in.,
f = friction factor,
s = specific gravity of the oil,
v = velocity of the liquid in feet per second,
L = equivalent length of pipe, in feet,
D = diameter of the pipe, in inches, and
Q = flow of oil in gallons per minute

In any given instance, all the factors required to determine the pressure drop are known except that for friction (f). Numerous investigations and exhaustive analyses have been made of the formulas to determine an expression or value for friction with the result that it is now an accepted fact that the friction factor is a function of the pipe diameter, density and viscosity of the fluid, and the velocity of flow.

Of these terms, viscosity requires further explanation. As previously stated, viscosity is usually measured in Saybolt Universal seconds or Saybolt furol seconds, the latter being approximately one-tenth of the former. Viscosity, so determined, is in terms unsuitable for use in the flow formulas, as they require viscosity in centipoise which is defined as the unit of absolute viscosity. The absolute viscosity is further defined as the product of kinematic viscosity and specific gravity, the relationship being expressed as follows:

$$Z = ks \qquad (3)$$

where Z = absolute viscosity in centipoise,
k = kinematic viscosity in centistokes, and
s = specific gravity

Kinematic viscosity is expressed by Nelson ("Petroleum Refinery Engineering") as follows where (t) is the Saybolt Universal viscosity:

$$k = \frac{Z}{s} = 0.219\, t - \frac{149.7}{t} \qquad (4)$$

The value of k can then be substituted in equation (3) and this relationship solved for the absolute viscosity (Z).

TABLE 2.—A.P.I.—SPECIFIC GRAVITY CONVERSION

A.P.I. Degrees	Specific Gravity	A.P.I. Degrees	Specific Gravity	A.P.I. Degrees	Specific Gravity	A.P.I. Degrees	Specific Gravity
11	0.993	21	0.928	31	0.871	41	0.820
12	0.986	22	0.922	32	0.865	42	0.816
13	0.979	23	0.916	33	0.860	43	0.811
14	0.973	24	0.910	34	0.855	44	0.806
15	0.966	25	0.904	35	0.850	45	0.802
16	0.959	26	0.898	36	0.845	46	0.797
17	0.953	27	0.893	37	0.840	47	0.793
18	0.947	28	0.887	38	0.835	48	0.788
19	0.940	29	0.882	39	0.830	49	0.784
20	0.934	30	0.876	40	0.825	50	0.780

TABLE 3.—KINEMATIC VISCOSITY CONVERSION CHART

$$k = 0.219\,t - \frac{149.7}{t}$$

Saybolt Universal Seconds	Kinematic Viscosity, Centistokes	Saybolt Universal Seconds	Kinematic Viscosity, Centistokes	Saybolt Universal Seconds	Kinematic Viscosity, Centistokes
t	k	t	k	t	k
100	20.40	475	103.68	1750	384.
105	21.07	500	109.20	1800	395.
110	22.74	525	114.71	1850	405.
115	23.90	550	120.13	1900	417.
120	25.05	575	125.74	1950	427.
125	26.20	600	131.25	2000	438.
130	27.30	625	136.76	2050	450.
135	28.44	650	142.07	2100	461.
140	29.58	675	147.78	2150	471.
145	30.52	700	153.09	2200	483.
150	31.85	725	158.70	2250	493.
155	32.99	750	164.10	2300	504.
160	34.12	775	169.61	2350	515.
165	35.19	800	175.11	2400	526.
170	36.52	825	180.62	2450	537.
175	37.45	850	186.12	2500	548.
180	38.57	875	191.63	2550	559.
185	39.69	900	197.03	2600	570.
190	40.91	925	202.54	2650	581.
195	41.93	950	207.94	2700	592.
200	43.05	975	213.35	2750	603.
210	45.29	1000	219.00	2800	614.
220	47.52	1050	230.00	2850	625.
230	49.85	1100	241.00	2900	635.
240	51.98	1150	252.00	2950	646.
250	54.20	1200	263.00	3000	657.
260	56.42	1250	274.00	3100	679.
270	57.65	1300	285.00	3200	700.
280	60.86	1350	296.00	3300	722.
290	63.08	1400	307.00	3400	744.
300	65.20	1450	318.00	3500	766.
325	70.74	1500	329.00	3600	788.
350	76.22	1550	340.00	3700	810.
375	81.80	1600	351.00	3800	832.
400	87.23	1650	362.00	3900	854.
425	92.80	1700	373.00	4000	876.
450	98.17				

Having converted the Saybolt viscosity into units applicable to the flow equation, we have only to evaluate the friction factor to determine the pressure drop. Through the analysis of the factors influencing the degree of friction in fluid flow in pipes by Reynolds, the expression $\frac{D\,v\,s}{z}$, known as the Reynolds Number, was developed and accurately correlates these several variables. It is a dimensionless number, hence it does not depend on the system of units employed as long as the units are consistent. For viscous or streamline flow,

$$f = 0.00207\,\frac{z}{D\,v\,s}$$

which when substituted in the Fanning equation (1) results in the Poiseuille formula

$$p = 0.00668\,\frac{z\,v\,L}{D^2}$$

usually used for viscous flow. It should be noted that viscous or streamline flow occurs in steel pipe up to a value of the Reynolds number of 0.122, according to the Poiseuille formula. For values of $\frac{D\,v\,s}{z} > 0.122$ the relationship becomes complicated, but exhaustive tests have shown that for each value of $\frac{D\,v\,s}{z}$ there is a definite value of (f) which shows the relationship of Reynolds criterion to the friction value for new steel pipe (Fig. 4). Because of the lower friction factor obtaining beyond the point of critical velocity, pipe sizes should be chosen so that the flow is in the turbulent range where possible.

TABLE 4.—VELOCITIES IN PIPE OF VARIOUS SIZES FOR VARIOUS RATES OF FLOW

Flow, G.P.M.	Nominal Pipe Diameter, Inches								
	¾	1	1¼	1½	2	2½	3	4	6
	Velocity, Feet per Second								
5	3	1.85	1.05	0.79	0.48	0.334	0.216	0.126	0.057
10	6	3.70	2.10	1.58	0.96	0.668	0.432	0.252	0.114
15	9	5.55	3.15	2.37	1.44	1.002	0.648	0.378	0.171
20	12	7.40	4.20	3.16	1.92	1.336	0.864	0.504	0.228
25	15	9.25	5.25	3.95	2.40	1.670	1.080	0.630	0.285
30	18	11.10	6.30	4.74	2.88	2.004	1.296	0.756	0.342
35	21	12.95	7.35	5.53	3.36	2.338	1.512	0.882	0.399
40	24	14.80	8.40	6.32	3.84	2.672	1.728	1.008	0.456
45	27	16.65	9.45	7.11	4.32	3.006	1.944	1.134	0.513
50	30	18.85	10.50	7.90	4.80	3.340	2.160	1.260	0.570
55	33	20.35	11.55	8.69	5.28	3.674	2.376	1.386	0.627
60	36	22.20	12.60	9.48	5.76	4.008	2.592	1.512	0.684
65	39	24.05	13.65	10.27	6.24	4.342	2.808	1.638	0.741
70	42	25.90	14.70	11.06	6.72	4.676	3.024	1.764	0.798
75	45	27.75	15.75	11.85	7.20	5.010	3.240	1.890	0.855
80	48	29.60	16.80	12.64	7.68	5.344	3.456	2.016	0.912
85	51	31.45	17.85	13.43	8.16	5.678	3.672	2.142	0.969
90	54	33.30	18.90	14.22	8.64	6.012	3.888	2.268	1.026
95	57	35.15	19.95	15.01	9.12	6.346	4.104	2.394	1.083
100	60	37.00	21.00	15.80	9.60	6.680	4.320	2.520	1.140
110	66	40.70	23.10	17.38	10.56	7.348	4.752	2.772	1.254
120	72	44.40	25.20	18.96	11.52	8.016	5.180	3.024	1.368
130	78	48.10	27.30	20.54	12.48	8.684	5.616	3.276	1.482
140	84	51.80	29.40	22.12	13.44	9.352	6.048	3.528	1.596
150	90	55.50	31.50	23.70	14.40	10.020	6.480	3.780	1.710
160	96	59.20	33.60	25.28	15.36	10.688	6.912	4.032	1.824
170	102	62.90	35.70	26.86	16.32	11.356	7.344	4.284	1.938
180	108	66.60	37.80	28.44	17.28	12.024	7.776	4.536	2.052
190	114	70.30	39.90	30.02	18.24	12.692	8.208	4.788	2.166
200	120	74.00	42.00	31.60	19.20	13.360	8.640	5.040	2.280

Since the Fanning formula is based upon the flow in new steel pipe, it is necessary to introduce a correction factor for the surface condition of the inside of the pipe. While new pipe is generally used at the time of installation, provision must be made for the condition of the inner surface of the pipe as it will be after several years of service due principally to corrosion. It is known that the friction in small pipes is affected to a greater extent than in large pipe by the condition of the surface; in fact, badly corroded pipe has indicated a possible increase of over 200% due to corrosion. For this reason, the pressure drop calculated from equation (1) or (2) must be multiplied by a roughness or age factor. A reasonable average value of 1.25 should be used to correct the friction factor obtained from Fig. 4. However, it is simpler to make the correction to the constant in the

basic formulas, after which, for steel pipe, we have:

$$p = 0.404 \frac{f s v^2 L}{D} \text{ or } 0.067 \frac{f s L Q^2}{D^5} \quad \ldots\ldots (5)$$

The solution of problems involving the flow of fluids has been extensively discussed in technical literature with the desire to cover the broadest possible field and include the greatest possible range of fluids. The purpose of the present theoretical analysis and practical examples to follow is to consolidate only such data and information as is necessary for the design of fuel oil handling and distribution systems in industrial plants. While the various factors are readily computed except viscosity, it is less cumbersome and will save considerable time to refer to the tables and charts which are a part of this article.

In addition to the proper sizing of pipe lines, the horsepower required by unloading and delivery pumps is an essential part of the specification of the equipment. The total horsepower to drive a pump depends upon (1) friction loss in the pipe main, (2) height to which the liquid is to be elevated, and (3) loss through pump, drive and motor. A fourth loss occurs when there is a sudden increase or decrease in the main size. Since this can be of considerable relative magnitude, such occurrences should be avoided. Horsepower (H) may be expressed by the relationship:

$$H = 0.000582 \frac{P \times G \times s}{E_p \times E_m \times E_d} \quad \ldots\ldots (6)$$

where G = flow in gallons per minute,
P = total pumping head in pounds per square inch,
s = specific gravity,
E_p = pump efficiency,
E_m = motor efficiency, and
E_d = drive efficiency

The motor and drive efficiency can be taken as approximately 80-90% depending on the type of drive, whether it is by flexible coupling, silent chain, V-belt, or gears. For practical purposes, a pump efficiency of 50% can be assumed when specifying the size of motor to drive positive displacement type pumps.

Total pumping head used in the horsepower formula includes both the friction drop in the line plus the elevation to which the oil is to be raised. The measurement of elevation being made in feet, it is necessary to convert it to equivalent pounds per square inch in order to satisfy the units of the equation. To avoid this conversion, the formula for total horsepower has been arranged to take into account these conversion constants and at the same time to eliminate the efficiency factors by including average figures of $E_p = 50\%$ and $(E_m + E_d) = 85\%$.

$$H = \frac{G s}{1700} (2.328 p + h) \quad \ldots\ldots (7)$$

where G = gallons per minute,
s = specific gravity,
p = pressure drop in pounds per square inch, and
h = difference in oil level in feet

The foregoing summarizes the formulas used in determining friction, pipe sizes and horsepower, and briefly explains their derivation. For practical purposes, reference need be made only to the following formulas and tables in solving distribution problems:

Absolute viscosity ..... Formula (3)
Reynolds number ..... $\frac{Dvs}{Z}$
Pressure drop ..... Formula (5)
Horsepower ..... Formula (7)
Specific gravity correction ..... Formula (8)
Friction factor ..... Figure 4
Viscosity S.U.S. ..... Figure 6
Specific gravity ..... Table 2
Kinematic viscosity ..... Table 3
Velocity ..... Table 4
Resistance of valves and fittings ..... Table 5

Practical Applications

To illustrate the method of designing fuel oil stor-

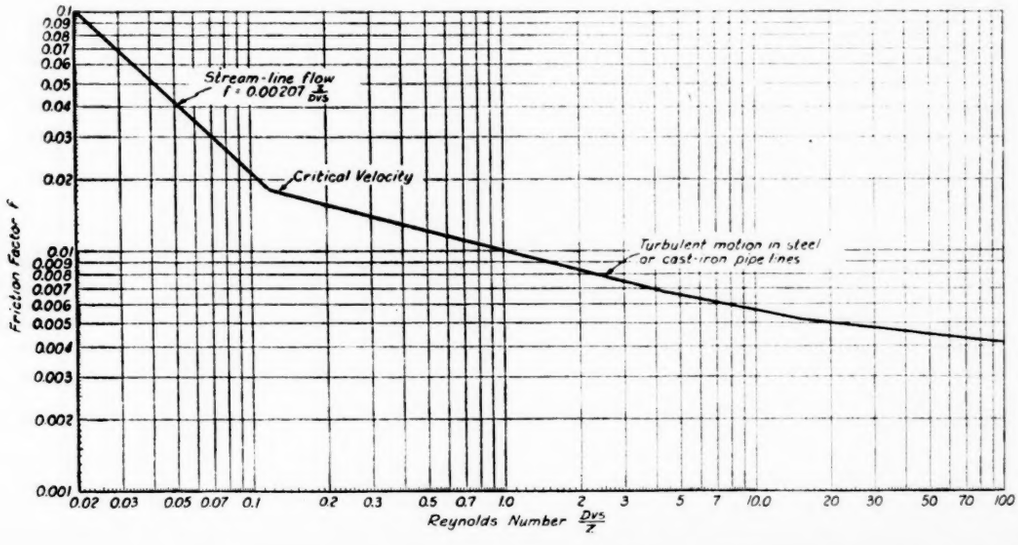


Fig. 4. Friction factors plotted against Reynolds numbers for new steel pipe.

age and distribution systems, the following problem will indicate the procedure and application of the formulas and use of the charts and tables.

Problem: — A forge shop has ten furnaces, requiring a simultaneous demand of 1980 gph of fuel oil. Because of the type of burners employed, No. 5 fuel oil of 20 A.P.I. gravity will be used and must be delivered to the burners at a pressure of 35 p.s.i. and have a viscosity not exceeding 150 S.U.S. Determine the main sizes and horsepower required for the circulating pump.

Analysis of Problem: — A study of the plant layout and individual furnace demands results in the schematic diagram of the problem as shown in Fig. 5 with linear distances and elevations indicated. As previously stated, the fuel oil should have a viscosity of about 1000 S.U.S. for normal pumping. From Fig. 6 it is seen that a No. 5 fuel oil will have a viscosity of 1050 S.U.S. at 100F, hence this temperature should be maintained in the storage tank. In the statement of the problem, the viscosity at the burners is specified not to exceed 150 S.U.S. Referring again to the characteristics of typical fuel oils (Fig. 6) it is seen that the No. 5 fuel oil must be heated in a preheater to 175-180F to meet this requirement. The heater will be specified to have a pressure drop not exceeding 10 p.s.i.

Before the sizing of mains can be determined, the specific gravity, kinematic and absolute viscosities must be obtained. From Table 2 the specific gravity corresponding to an A.P.I. gravity of 20 is found to be 0.934 at 60F. Since the specific gravity is usually specified at standard conditions of 60F/60F correction must be made to obtain the specific gravity at the operating temperatures of 100F and 180F. This can be done by substitution in the following formula:

$$S_2 = S_1 \frac{V_1}{V_1 + a\,V_1\,(t_2 - t_1)} \qquad (8)$$

where t_1 = initial temperature, F,
t_2 = final temperature, F,
V_1 = initial volume at temperature t_1 = unity,
S_1 = initial specific gravity at temperature t_1,
S_2 = final specific gravity at temperature t_2, and
a = coefficient of cubical expansion equal to 0.0005 (average) per F.

To illustrate, for determining the specific gravity at 100F, we have, by substitution,

$$S_{100} = 0.934 \frac{1}{1 + [0.0005 \times 1 \times (100 - 60)]}$$

$$S_{100} = 0.934 \frac{1}{1.02} = 0.915$$

From Table 2 the corresponding A.P.I. gravity is 23. Similarly, the specific gravity and A.P.I. gravity at 180F is found to be 0.881 and 29 degrees, respectively.

Properly to maintain the oil temperature at the burners, it is decided that a recirculating system is necessary and that the delivery pump shall have a capacity equal to 150% of the simultaneous burner demand of 1980 g.p.h. or 49.5 g.p.m. Since the location of the furnaces necessitates three branch distribution lines, the pump discharge must be apportioned for each line and the supply and return branches sized accordingly to insure each branch receiving its required flow. To simplify the calculations, it will be assumed that no recirculation is required between the burners and the overhead distribution mains; therefore, each section of the system will have the following flow conditions:

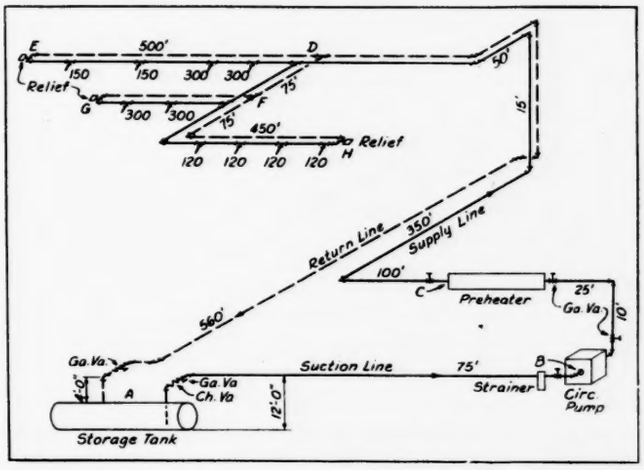


Fig. 5. Layout for forge shop referred to in the accompanying problem and for which the oil piping is sized.

Branch	Peak Load G.P.H.	Peak Load G.P.M.	Supply G.P.M.	Return G.P.M.
F-H	480	8.0	12.0	4.0
F-G	600	10.0	15.0	5.0
D-E	900	15.0	22.5	7.5
D-F	1080	18.0	27.0	9.0
A-D	1980	33.0	49.5	16.5

Because the volume of oil flowing is small, it will be more practical to consider the total branch requirement as flowing through the entire branch main and determine the pipe size without deducting the demands taken off for each furnace in the branch.

From the foregoing analysis of the problem, all the basic data have been ascertained for the calculation of the distribution system and horsepower of the pump. For convenience, these data are summarized as follows for the two temperatures at which the fuel oil will be handled—namely, 100F from storage to preheater and 180F from preheater to burners:

	At 100F	At 180F	Reference
A.P.I. degrees	23	29	Table 2
Specific gravity (s)	0.915	0.881	Equation (8)
Saybolt viscosity (S.U.S.)	1050	145	Fig. 6
Kinematic viscosity (k)	230.0	30.52	Tab'e 3
Absolute viscosity (Z)	211.0	26.9	Equation (3)

Determination of Suction Lift: From the diagrammatic layout (Fig. 5), the vertical lift is 12 feet from the bottom of the storage tank to the inlet of the circulating pump, and to this must be added the frictional resistance or pressure drop through the suction line, valves, fittings and strainer.

It has been found that a total maximum suction lift of 20 feet for heavy grades of liquids is sound engineering practice, although a limit of 24 feet has been used.

TRIAL 1: Assume a diameter of 2½ in. for the suction pipe and determine the suction required for the flow of 49.5 g.p.m. of fuel oil at 100F. From Table 4 the velocity is equal to 3.34 ft per sec. Substituting in the formula for Reynolds number

$$R = \frac{D\,v\,s}{Z} = \frac{2.469 \times 3.34 \times 0.915}{211.0} = 0.0357$$

Referring to the friction factor chart, Fig. 4, the friction factor corresponding to a Reynolds number of 0 0357 in the viscous flow region is 0.057.

Next determine from Table 5 the equivalent length of the suction line.

	Feet
Actual length, 2½ in. pipe	75
3—2½ in. elbows @ 6 ft each	18
1—2½ in. check valve @ 8 ft	8
2—2½ in. gate valves @ 2.1 ft each	4.2
1—2½ in. strainer @ 5 ft (assumed)	5
Equivalent length	110.2

Substituting in equation (5), the pressure drop becomes:

$$p = \frac{0.404 \times 0.057 \times 0.915 \times (3.34)^2 \times 110}{2.469}$$

$$= 10.5 \text{ lb per sq in.} = 10.5 \times 2.31 = 24.2 \text{ feet}$$

Add to this the 12 feet vertical lift and the total suction lift is 24.2 + 12 = 36.2 feet which is obviously impossible.

TRIAL 2: Assume a 3 inch diameter suction pipe. From the tables and charts the following results are obtained:

Internal diameter, D	3.068
Velocity (Table 4), V	2.16
Reynolds No., R	0.0289
Friction factor (Fig. 4), f	0.071
Equiv. length pipe (Table 5), L	119.0
Pressure drop (Eq. 5), p	4.75 lb per sq in. or 11.0 feet
Vertical lift	12.0
Total suction lift	23.0

TABLE 5.—RESISTANCE TO FLOW OF OIL IN VALVES AND FITTINGS

Pipe Dia., Inches	Type of Fitting					
	Elbow	Tee	Check Valve	Gate Valve	Angle Valve	Globe Valve
	Equivalent Length of Straight Pipe, Feet					
1	3	6	3	0.8	4	9
1½	4	8	5	1.2	6	12
2	5	10	7	1.7	9	15
2½	6	12	8	2.1	11	18
3	8	16	10	2.5	13	24
4	10	20	13	3.3	17	30
6	15	30	20	5.0	25	45
8	20	40	27	6.7	34	60
Approx. Pipe Diameters	30	60	40	1.0	50	90

TRIAL 3: Since a 3 in. suction pipe is also too small, another assumed size must be made. By similar calculations it can be shown that the pressure drop through a 4 in. suction pipe will be equal to 16.1 feet or 6.97 lbs per sq in, and as this is less than the 20 feet maximum allowable total suction lift, this size will be selected as satisfactory.

DETERMINATION OF PUMPING HEAD: The same procedure is followed in applying formulas and tables in the computation of the pumping, or discharge, head as was used in determining the suction lift. Whereas a limit of 20 feet was placed on the allowable total suction including vertical lift and friction loss, no such restrictions affect the discharge head since it is always possible to specify a motor of sufficient capacity. However, careful judgment should be exercised in this respect and such factors as cost of electric power, operating time of the system, overhead and maintenance charges must be balanced against the initial cost of the installation.

As an illustration, consider section C—D of the delivery line (Fig. 5) where the fuel oil leaves the heater and is pumped to the first branch at point D after being elevated 15 feet. The following tabulation of the horsepower required to deliver the oil through this section of main for several assumed pipe sizes clearly indicates the care with which distribution lines must be sized.

D	V	R	f	L	p	Hp.
(2 in.)	2.067	4.80	0.287	0.0140	782	44.3	3.06
(2½ in.)	2.469	3.34	0.238	0.0148	788	22.5	1.75
(3 in.)	3.068	2.16	0.191	0.0157	800	10.2	1.01
(4 in.)	4.026	1.26	0.147	0.0170	813	3.8	0.36

An approximate rule might be established to consider a pressure drop of 1.5 pounds per square inch per 100 feet of pipe as the maximum allowable friction drop permissible in a discharge main. On this basis the 3 in. pipe size should be selected and the remainder of the recirculating system sized accordingly as summarized in the following table:

Section	GPM	Pipe Diam., In.	Velocity, Ft/per sec.	Modulus Dvs/z	Friction factor (f)	Equivalent Length, Ft.	Pressure Drop, Lb per sq in.
			Supply Line				
B-C	49.5	4.026	1.260	0.022	0.092	62	0.83
C-D	49.5	3.068	2.160	0.191	0.016	800	10.20
D-E	22.5	2.469	1.670	0.119	0.019	554	4.15
D-F	27.0	2.469	2.004	0.143	0.017	87	0.86
F-G	15.0	2.067	1.440	0.086	0.024	325	2.78
F-H	12.0	2.067	0.960	0.057	0.037	575	3.36
			Return Line				
H-F	4.0	1.610	0.790	0.037	0.057	541	4.26
G-F	5.0	1.610	0.790	0.037	0.057	312	2.46
F-D	9.0	2.067	0.960	0.057	0.037	85	0.50
E-D	7.5	2.067	0.960	0.057	0.037	515	3.01
D-A	16.5	2.469	1.002	0.071	0.029	869	3.63
						Total pressure drop due to friction	36.04
						Add loss through heater	10.00
						Add vertical pumping head (25 ft.)	10.80
						Add pressure required at burners	35.00
						Total discharge head required at pump	91.84

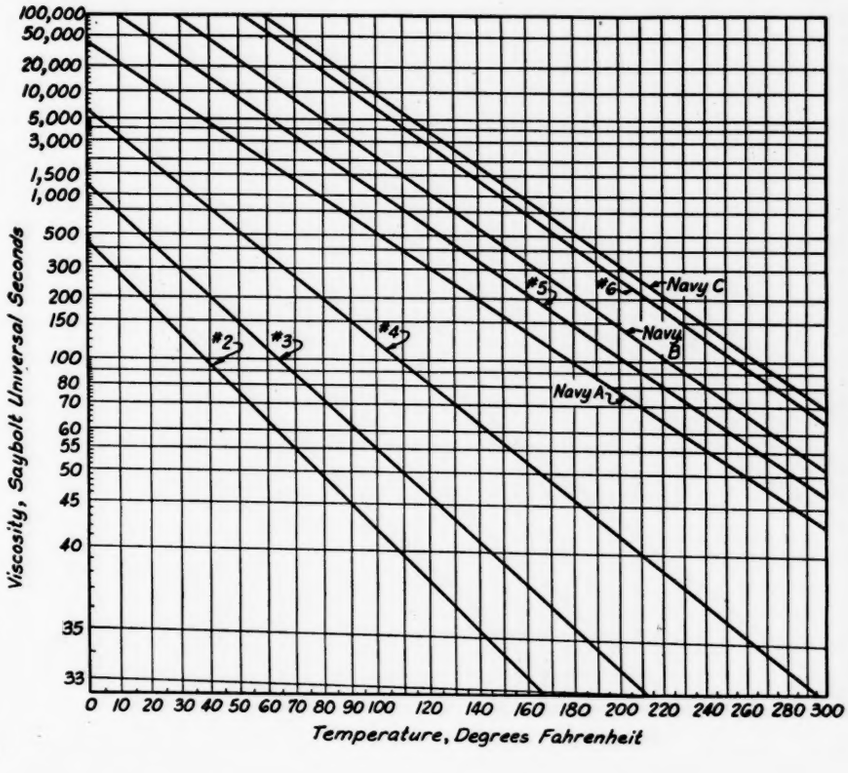


Fig. 6. Characteristics of typical fuel oils plotted on a skeleton of the Standard Viscosity Temperature Chart of the American Society for Testing Materials.

DETERMINATION OF HORSEPOWER. It is necessary to calculate the horsepower required from equation (7) for each section of the main, as for example, section C—D.

$$H = \frac{Gs}{1700}(2.328\,p + h) =$$

$$\frac{49.5 \times .881}{1700} \times [(2.328 \times 10.20) + 15]$$

$$= 1.005$$

In a similar manner, the horsepower for each section can be obtained, bearing in mind that the (h) for section D—A of the return main is —29 feet. The total horsepower is 4.364. Since it was assumed that the maximum flow in each branch was carried the entire length of the branch main, sufficient factor of safety has already been included so that the horsepower as computed is ample. The nearest size of standard motor is 5 hp and this should be specified. The computed horsepower to overcome friction through the piping, heater, strainers, etc., and to elevate the oil is 2.194 to which must be added the horsepower to develop the 35 lb pressure required at the burner. Hence H = 2.194 (friction and elevation) + 2.170 (35 lb terminal pressure) = 4.364 hp.

In the above example, it was necessary to assume D and calculate for the friction factor. In so doing, it is desirable to select a diameter which will result in a Reynolds number in the turbulent flow region. However, on small size pipe this is not of great moment, as it can be shown that the velocity squared is of more importance than the reduction in the friction factor. When obtaining the velocity of flow from Table 4, the flow rate was used nearest to the actual required. An error is introduced here which is of less importance as the flow increases. For this reason, when the flow is extremely small and a high degree of accuracy is desired, the velocity should be calculated from the formula.

Summary

In the design of a fuel oil system, probably the most important factor is to install the circulating pumps so that the suction lift (when storage tanks are below ground) is within practical limits. For heavy oils the vertical lift plus friction loss may equal 20 feet and in some cases higher; but 14-18 feet are good limits for light oils and distillates. For gasoline and other volatile liquids, even 14 feet is too great a suction lift.

The correct specification for the delivery pump in the foregoing problem should read:

(1) Capacity .....50 g.p.m.
(2) Suction lift .....16 feet
(3) Discharge head .....92 lb per sq in
(4) Motor size .....5 hp
(5) Liquid pumped .....No. 5 fuel oil

(a) Viscosity S.U.S. at 100F 1100

The A.P.I. gravity or the specific gravity should be obtained from the oil supplied for the handling temperatures; however, the change in specific gravity due to the increase in temperature can be calculated and the new A.P.I. obtained from the tables.

A well-planned pump house should have adequate ventilation even though the handling of fuel oils is not considered a flammable liquid hazard such as gasoline, kerosene, naphthas, etc.

It is not considered good practice to return the condensate from steam coils or heaters to the boilers because of the possibility of leaks permitting oil to get into the condensate return lines, even though this occurrence is remote. Consequently the condensate is wasted to the sewer after having been cooled to a temperature below 110F and having passed through a protecting oil separator chamber.

The layout of the factory distribution system should include provision for sectionalizing the mains.

Relief valves at E, G and H should be installed so that they are open at least fifty per cent for maximum flow. If the valves are too large, then their operating range is restricted to such a small opening that fluttering and chattering will occur.

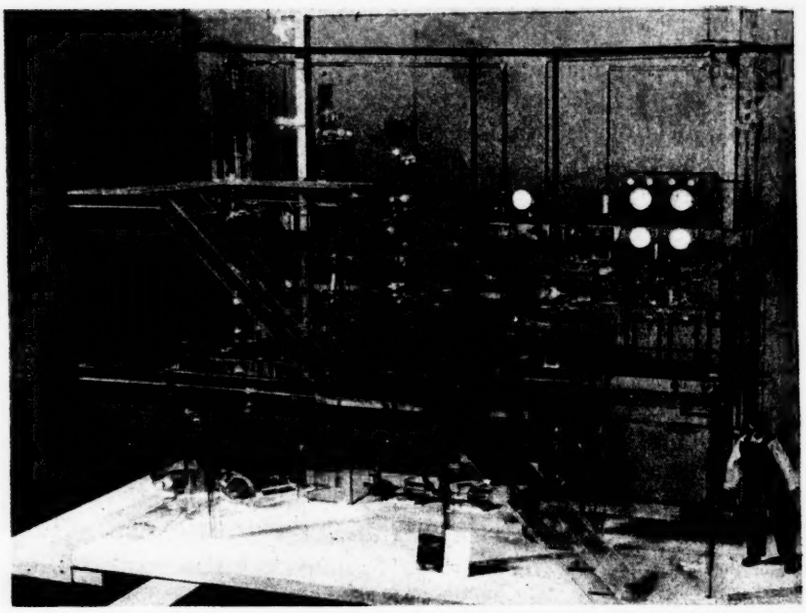
In general, industrial fuel oil storage and distribution systems require little maintenance when properly designed, installed and operated.

Picture Paragraphs

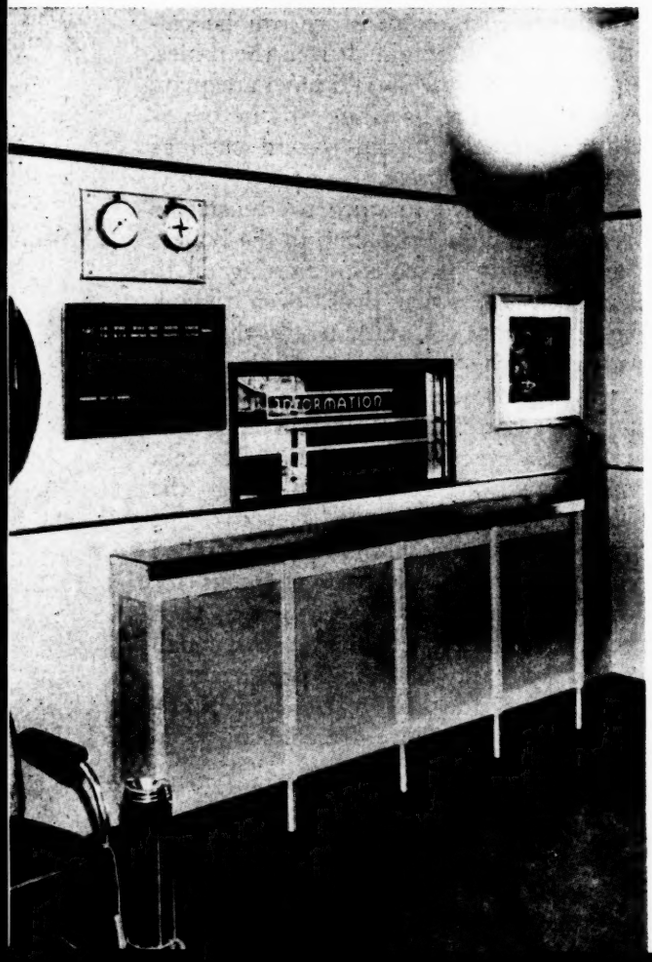
A brief record of novel developments

Forty new salesmen of the Minneapolis-Honeywell Regulator Co. were given a course for two weeks on principles of control systems. The students had an 8-hour school day and heard lectures by 12 of the company's specialists. Most of the men had a good heating background before starting school.

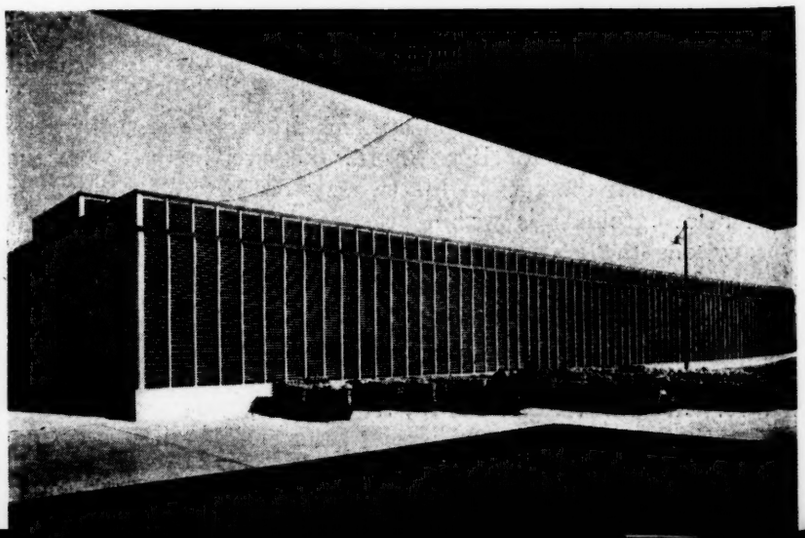
Weather information is available in the lobby waiting room of The Allen Corp., Detroit, Mich. Although weather forecasting is only local, as compared with the U. S. Weather Bureau releases, the information has been 96% accurate. The meteorological data have proven of value to the company. Figures are posted on wind velocity, wind direction, barometric reading, and weather conditions for various parts of the day.



Plastic tubing and sheets were used by Dewey and Almy Chemical Co., Cambridge, Mass., to construct models of new plants before actual erection is started. Models are scaled to one inch to the foot. Before this new technique of model making was employed, bent wires were used to represent piping and equipment was shown by wood blocks. Models save pipefitters' time and reduce the number of job changes.



Wright Lockland cooling tower, made by the Marley Co., Kansas City, Kans., is of the induced draft type. It cools 20,000 gpm from 95 to 85F when the wet bulb temperature is 78F.



WASHINGTON NEWS

Bureau to Unify 3 Divisions; Better Buildings Now Possible; Freon Supplies to be Improved.

Summarized by LORING F. OVERMAN

With all eyes focused on the election at home and on the slowed-down German invasion abroad, it is understandable that Washington was in somewhat of a state of suspended animation during much of October.

Announcement of "topside" policy was being held in abeyance pending decision of one or both of the ballot and bullet battles, and little of startling significance to the heating, ventilating and air-conditioning industries seeped from the desks of lower-level post-war and post-election planners.

Construction Division Formed

Probably most important, from a long-range viewpoint, was the establishment of a Construction Bureau within the War Production Board. Previous to the setting up of this bureau there was no division in the WPB to deal with the reconversion problems of reconstruction. There was also no industry advisory committee to present the needs and opportunities to provide employment in the transition period of this important industry.

The new Bureau will bring together under unified direction three important industry divisions, the Building Materials Division, the Plumbing and Heating Division, and the Construction Machinery Division. It will be responsible for developing and carrying out at the earliest practicable time plans to release metals and manufacturing facilities for the manufacture of building equipment. It has also before it proposals to permit the early liberalization of the Construction Order, L-41, to permit limit construction of many needed types, provided they do not interfere with war work.

Claimant Status

Establishment of the Construction Bureau gives the widely varied construction industry a strong representative in court, a claimant agency fully recognized and authorized to present recommendations and make claims on behalf of the industry as a whole. Quite obviously, an announced program having the backing of the Construction Bureau, would carry with it all of the units that enter into construction itself. This represents an important forward step, proponents of the plan believe, since the component parts of the industry would be pulling together toward a common goal, instead of possibly hindering an overall program by bidding against each other for limited supplies of material and manpower.

Arthur J. McComb, Montclair, N. J., a former vice-president of the Otis Elevator Company, will direct the new Construction Bureau. He went with WPB in June, 1944, as director of the Office of Industry Advisory Committees.

12,600,000 Units Needed

Doubtless one of the first assignments of the new Construction Bureau will be to consider the premise, advanced on October 21 by John B. Blandford, Jr., National Housing Administrator, that 12,600,000 nonfarm houses and apartment units will be required during the first post-war decade to meet the needs of American families and to make substantial progress in replacing substandard structures with good homes.

The estimate, Mr. Blandford said, was made after careful study of available information, "as an earnest effort to judge the size of the nation's housing needs—not as an announcement of a program."

Assuming that government controls will be continued during at least the early phases of meeting such requirements, it would be one of the tasks of the WPB Construction Bureau to blend the NHA estimate of residential need into the general picture of over-all construction needs, and to make recommendations tailoring the available cloth to the figure as a whole.

The magnitude of NHA's estimated need for 1,260,000 new residential units yearly for 10 years can be judged from the fact that the nation's biggest residential building year (1925) produced about 930,000 new units and an annual average of 700,000 was recorded from 1920 to 1929. Non-farm home construction then fell to a low level of 93,000 in 1933 and slowly rose to about the 1920-29 average by 1941, when 715,000 homes were built.

Planners' Problem

The need for engineers in the H&V field to inform themselves at once regarding post-war models to be produced, and the need for manufacturers to make such information available, was highlighted on October 16 when WPB authorized purchasers to place and manufacturers to accept post-war purchase orders to be filled after the removal of applicable WPB restrictions. Accompanying the authorization, expressed in Interpretation 11 to Priorities Regulation No. 1, was the following explanation:

"Some orders and regulations of the War Production Board forbid the placing or acceptance of purchase orders for certain materials or products unless the purchase orders bear specified preference ratings, or unless they are accompanied by an allotment symbol or special authorization, or unless they meet some other condition. Such provisions do not, however, prohibit the placing or acceptance of a purchase order which, by its express terms, is not to be filled until after removal of such restrictions by the War Production Board.

"A manufacturer may not schedule such orders for production, order material or place material in production to fill such orders until after the applicable restriction is removed."

Industry Applies Brakes

It is the source of some little amusement in WPB circles that the War Production Board's new boss, Chairman J. A. Krug, apparently got out in front of his interference when he announced, late in September, that the end of the war in Europe would bring immediate revocation of some 350 of WPB's 500 limitation and conservation orders. Although WPB controls over manufacture and distribution have been roundly cussed from all angles, the prospect of waking up some morning and finding most of these controls removed proved somewhat of a shock to recipients of what was intended to be good news.

Many industry advisory committees observed that the pendulum was swinging from "too many" controls to "too few," and there were plenty of suggestions that it might be better to make haste slowly. At any rate, Chairman Krug had an-

nounced tentative plans to publish, on October 10, a list of the orders slated for revocation. Publication of the promised list was delayed from day to day, for one reason or another, and as H&V went to press, identity of the orders scheduled for the discard were still a secret.

Spot Plan Catches On

While it is likely that the slowdown of the invasion of Germany has had a bearing on the temporary smothering of the Krug revocation plan, it is interesting to note that the somewhat-belittled spot authorization plan announced as one of the final acts of former WPB Chairman Donald Nelson is beginning to click. This plan authorized limited resumption of civilian production, at the discretion of WPB field offices, but only if the planned civilian activities would take neither manpower nor needed materials from the war effort.

It was claimed that the spot authorization plan was too cumbersome, and that before it could be placed in operation, it might be expected that both the European and Pacific conflicts would be over. However, on October 24, WPB announced that a total of $152,441,000 of civilian production has been authorized for the current quarter and for the first three quarters of 1945 in 940 separate authorizations by WPB field offices. Of this total, $44,816,000 of civilian production has been authorized for the current quarter of 1944.

Better Construction Approved

Encouraging to all whose designing and engineering talents have been limited by War Housing Construction Standards is the October 17 relaxation of restrictions on the use of materials, to permit construction of houses approximating pre-war standards. This action was taken jointly by WPB and NHA by revision of Schedules I and II of Limited Preference Rating Order P-55-c. Under the relaxations, houses can be built to conform to minimum construction requirements of the Federal Housing Administration under Title II of the National Housing Act.

The War Housing Critical List, which previously contained all the materials that might be permitted in residential construction, is now designed to cover only those materials for which a priority rating is required. Any materials that can be obtained without a rating may now be incorporated in the construction, unless specifically prohibited in the list.

Principal relaxations include:

1. Removal of the limitation on the number of electrical outlets so that installations may be made in accordance with minimum requirements of the National Electric Code.

2. Removal of the restrictions on the size of hot water storage tanks. This change, it was said, should result in fuel savings and longer tank life. Since electric water heaters are now being manufactured for NHA use, restrictions against such installations where there is a basement or utility room or where other fuels are available have been removed.

3. Removal of the requirement that bathrooms and kitchens must be back to back, to allow more freedom in design.

Furthermore, the plumbing items on the critical lists have been condensed and simplified and the heating section has been completely revised, eliminating the previous tight control over the system design. Insulation is still required to avoid excessive heat loss.

While most of the changes authorized will be immediately reflected in improved construction of individual housing units, the relaxations are of interest as an indication that an early return to pre-war standards —or perhaps to the improved standards of post-war type—are in the making for all types of construction.

A-C IAC Meets

The current Freon-12 shortage is expected to be improved soon as a result of additional allotments of hydrofluoric acid, a component, the WPB reported on October 18 to members of the General Refrigeration and Air Conditioning Industry Advisory Committee. Plants may expect sufficient amounts of hydrofluoric acid to produce 12,000,000 pounds of Freon-12 during the fourth quarter, it was reported. Producers have previously requested that enough acid to produce 16,500,000 pounds be supplied.

By February enough of the acid is expected to keep Freon-12 plants operating at capacity, as the construction of two new hydrofluoric plants is expected to be completed at that time, a representative of the WPB Chemicals Bureau reported.

Members of the committee were also told that the possibility of programing limited production of such refrigeration and air conditioning items as ice cream dispensary cabinets, freezers and low temperature cabinets, soda fountains and self-contained air conditioning units before "Victory-in-Europe" Day is being explored. Production of such items is now prohibited by Order L-38.

The proposed action would shorten production delays three or four months after "VE-Day" and assist employment during the post-war period, WPB officials said. Otherwise, they asserted, the industry might have a six-month delay in the transition period between wartime and peacetime production to tool up plants, field test equipment and obtain materials.

Fractional horsepower motors are expected to be available after "VE-Day" to meet the industry's 1939 production level, committee members were told. Members also heard an explanation of an amendment revoking Schedule IV and V of Order L-126, which limits the use of critical materials in the manufacture of industrial and commercial refrigeration and air conditioning machinery and equipment. Schedule IV standardized valves, fittings, accessories and other components used in the manufacture of refrigerators and air conditioning units. Schedule V prohibited the use of ferrous and nonferrous metals in the exterior and interior of walk-in coolers.

WPB Wind Vane

Although few of the October reportable happenings in Washington affect the manufacturers or the designers and users of major units in the heating, ventilating and air-conditioning field, the relaxation of restrictions in the "little brother" group serve to point the general trend.

Since October 14, WPB has been accepting applications from oil burner manufacturers for permission to manufacture 30,000 domestic burners for which material has been authorized. Sale and installation of these burners to an ultimate consumer to replace one that is worn out, damaged beyond practical repair, or destroyed, are freed from restrictions under an amended version of Order L-74. However, sales for new installations must be approved by either the Petroleum Administration for War or the Office of Price Administration, depending upon which agency has jurisdiction over the use of fuel oil for the installation in question.

And since October 7, WPB field offices have been accepting applications to manufacture 37,500 domestic type stokers recently authorized. WPB maintains no control over distribution of stokers at the manufacturer-distributor level. Actual installation of coal stokers is controlled by Order L-41, which permits installation of stokers without WPB approval, however, if the installation results in a saving of coal and if coal was formerly used as a fuel. Installation cannot cost over $5,000 and the total cost of the job, including cost of the equipment must not exceed $25,000. New installations of coal stokers which necessitate a change in fuel require WPB approval.

REVIEWS

RESEARCH BOOKLET

The American Society of Heating and Ventilating Engineers has issued a standard size, 37-page booklet devoted to the research projects being carried on at its laboratory in Cleveland and the cooperating universities on heating, ventilating and air conditioning subjects. A page is devoted to each of the projects now under way and under each is given the purpose of the project, the committee involved, the reason for undertaking, the specific objectives, type of research, and the general method of attack. A center spread lists each of the projects by general classification of such together with the names of the cooperating universities.

The booklet is available from the Director of Research, American Society of Heating and Ventilating Engineers Research Laboratory, 10700 Euclid Avenue, Cleveland 6, Ohio.

STACK EFFLUENTS

As the authors state, the discharge of gases and solids from stacks in the immediate vicinity of occupied buildings is a common occurrence, and one would naturally assume that considerable information on rates of dilution of such stack effluents would be available. However, review of the literature indicated that such was not the case. Information was needed in connection with preliminary plans for the Brooklyn-Battery vehicular tunnel from which it was proposed to discharge exhaust up to 1,000,000 cu ft per minute of forced air containing CO as a contaminant. Since the desired information was not available experiments on scale models of the buildings involved were conducted. The booklet contains the results together with analysis of the information collected in these tests.

The study not only filled the immediate purpose of providing the tunnel authorities with information on dilution of gaseous stack effluents, but has also yielded approximate data that have general practical application to all types of stacks.

Authors state that the general form of the stack-discharge stream is that of an expanding jet bent by the wind. The form, position in space, and contaminant content of the stream in the absence of extraneous turbulence can be expressed in terms of distance, measured in stack dimensions, for any ratio of wind velocity to stack velocity.

For undisturbed flow, maximum relative gas concentrations occur for a wind stack velocity ratio of 1.0, but at some distance the possible maximums over heights above the stack equal to horizontal distances from the stack are approximately the same. At 25 stack widths or stack diameters, the expected maximum concentration is about 10 percent of that in the stack, and at 50 widths or diameters it is about 5%.

Maximum relative concentrations at adjacent buildings were comparable to the maximums in undisturbed streams where building-generated turbulence was a minimum, but in general they were but one-sixth of one-tenth of these values.

No scale effect was observed. Test results on two models, with the scale of one of them half that of the other, agreed fully as well as duplicate tests on the same model.

Booklet is entitled "Dilution of Stack Effluents," by G. E. McElroy, C. E. Brown, L. B. Berger and H. H. Schrenk. 6 x 9 in., paper covered. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, 10c.

FIELD AIR SAMPLING

To overcome some of the inherent weaknesses of air sampling devices, the Illinois State Department of Public Health undertook to develop an instrument which would meet the following specifications: Air flow should be automatically, or at least semi-automatically, controlled; it should be simple in construction and at the same time rugged, and easy to operate; it should be applicable to both high and low sampling rates; parts should be easily accessible, and it should be light in weight. The field sampling unit developed is described for the benefit of those who would care to make one.

"An Automatically Controlled Suction Device for Field Air Sampling," A. Setterlind, American Journal of Public Health, August, 1944.

BRIEF REVIEWS

COKING PROPERTIES OF COAL—Giving war industries additional information on the adaptability of typical American coals to specific uses, the Bureau of Mines has completed a report listing the coking properties of nine commercially important coals from Western Province fields, Oklahoma, Kansas, and Arkansas, and the results obtained from blending some of these fuels. Carbonizing tests, such as those conducted by the Bureau in its laboratories, provide valuable indexes not only of the suitability of coals for producing coke for metallurgical plants and other industrial uses, but also reveal their value as sources of commercial gas and chemical byproducts.

Copies of Bureau of Mines Technical Paper 667, "Carbonizing Properties of Western Region Interior Province Coals and Certain Blends of These Coals," are obtainable through the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at 20 cents per copy. They are not for sale by the Bureau of Mines.

PIPE WELDING—Those engaged in shipbuilding will be interested in the "Rules for Fusion Welding Piping in Marine Construction," published by the American Welding Society. First published in 1938, this standard has now been revised to bring the original data for welding low-carbon steel (.35% max.) marine piping up to date. Among the topics included are: qualification of welding procedure; qualification of welding operators; design; layout and dimensions of piping; allowable types of joint; preheating; stress-relieving; radiographic tests; and hydrostatic tests. A 6 x 9 bulletin. American Welding Society, 33 West 39th St., New York 18, N. Y. Price, 25c.

REPORT ON COKING PROPERTIES—Continuing its investigations of the coking characteristics of typical American coals, the Bureau of Mines has completed a report describing the carbonizing properties of Pocahontas No. 3 bed coal from McDowell County, W. Va., and the effects of blending it with Pittsburgh bed coal from Westmoreland County, Pa. As in other examinations of carbonizing properties, Bureau research workers used the standard method developed by the Bureau of Mines and the Carbonization Committee of the American Gas Association, known universally as the BM-AGA carbonization test.

Copies of Bureau of Mines Technical Paper 670, "Carbonizing Properties of Pocahontas No. 3 Bed Coal from Kimball, McDowell County, W. Va., and the Effect of Blending this Coal with Pittsburgh Bed Coal," can be obtained only from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at 10 cents per copy. The paper is not for sale by the Bureau of Mines.

FEDERAL AGENCIES—A descriptive tabulation of the 428 functional units of the federal government. It lists the function of each of the various units, the year it was created, the amount of money appropriated for its use, and the number of persons employed. It also has a listing of extra-departmental and ex-officio agencies financed by other agencies. A section on the corporate branch lists the year when formed, the purpose of the corporation, and the capital. This booklet of 68 pages is very well cross indexed. Available from Citizens National Committee, Inc., 1409 L St., N.W., Washington, D. C., at 25c per copy.

HOG HOUSING.—A 16-page circular No. 701 of the U. S. Department of Agriculture, entitled "Hog-Housing Requirements," by T. A. Miller, Wallace Ashby and J. H. Zeller. Includes sections on recommended temperatures, ventilation, and insulation. Available from the Superintendent of Documents. Price, 5 cents.

COAL-ASH SLAG.—In the slag-tap furnaces, widely used by large steam generating plants, the efficiency of the plant is largely controlled by the behavior of the molten slag from the ash. In a report on "The Flow of Coal-Ash Slag on Furnace Walls," by P. Cohen and W. T. Reid, a method is given for evaluating the flow of slag on the furnace wall tubes. Detailed information is given on the method for making determinations. Technical Paper No. 663, price 10c. For sale by Superintendent of Documents, Government Printing Office, Washington, D. C.

COAL STORAGE—A Bureau of Mines Report of Investigations on "Domestic Storage of Subbituminous Lump Coal and Its Performance in a Hand-Fired Furnace." Standard size, multilithed, paper covered booklet containing 17 pages and dated June, 1944. Investigation demonstrated a method in which such coal can be stored successfully in a domestic bin. Paper by W. S. Landers and V. F. Parry. Designated as R.I.3759, Bureau of Mines. Available from the Superintendent of Documents.

OIL BURNER NOISE—A 68-page paper bound bulletin entitled "Combustion and Mechanical Noise in Automatic Mechanical-Draft Oil Burners," and containing a most comprehensive discussion of the subject as well as the result of tests, oscillograms, tables, and a bibliography, written by H. D. Brailsford, of the Underwriters' Laboratories, Inc., publishers of the booklet, which is No. 31 of the series, Bulletin of Research of the Laboratory, and available from them at 207 East Ohio St., Chicago, Ill. at no charge.

CONVERSION FACTORS—Practically every handbook ever published contains conversion factors and conversion tables of one kind or another for converting from metric to English units and vice versa. Unfortunately, however, it seems that the exact combination of units one is looking for is never to be found in the most convenient handbook. Consequently, the 262-page booklet entitled "Conversion Factors and Tables" by O. T. Zimmerman and Irvin Lavine, and which contains over 6000 conversion factors, fills a real need. It gives conversion factors for such compound units as Btu per inch per hour per square foot per degree F into or from gram calories per centimeter per hour per square centimeter per degree Centigrade, and similar combinations of heat units which are exceedingly involved to work out when translating. In addition to the conversion factors themselves, 38 pages of conversion tables are given. Book is 4¼ x 6 in., bound in blue with silver lettering, published by the Industrial Research Service, Dover, N. H. Price, $2.75.

THE PENNSYLVANIA ANTHRACITE INDUSTRY.—In its Manual of Statistical Information, the Anthracite Institute presents figures on the mining and movement of coal, as well as prices, that will give one a better understanding of the anthracite coal industry. It contains 31 tabulations covering information for the past 10 years. The institute hopes to make this an annual publication. Copies may be obtained from the Anthracite Institute, 101 Park Ave., New York 17, N. Y.

GOOD PUBLIC RELATIONS FOR THE GENERAL CONTRACTOR—As part of its public relations program for the general contracting industry, the Associated General Contractors of America has directed the preparation of a 24-page manual to aid the industry. Examples are given of how public good will can be merited, attained and kept. For copies write to Associated General Contractors of America, Inc., 1227 Munsey Bldg., Washington, D. C.

REFRIGERATION WITH AMMONIA—A 16-page illustrated booklet which covers the mechanical equipment for refrigeration with ammonia, properties of ammonia, pressure chart for various concentrations and temperatures, operating suggestions, and first aid in case of bad ammonia leaks. Available from Pennsylvania Salt Manufacturing Co., 1000 Widener Bldg., Philadelphia 7, Pa.

At the Twin City Meeting, A.S.R.E.

Honors for a record of having a long distance visitor at a meeting is being claimed by the Twin City Section of the American Society of Refrigerating Engineers. A. L. Mitchell, president of the New Zealand Institute of Refrigeration, Wellington, New Zealand, was present at a meeting of the section held October 16 at Minneapolis. He is at the right of the photograph shaking hands with R. J. Thompson of Kinetic Chemicals, Inc., Wilmington, Del., who spoke on Freon 22 at the meeting. In the center is Dr. R. C. Jordan, Chairman of the Twin City Section.

DIMENSIONAL AND CAPACITY DATA OF SCHEDULE 40 PIPE

Welded and Seamless Wrought-Iron and Wrought-Steel Pipe—Schedule 40, American Standards Association B-36-10

(NOTE—THIS PAGE SUPERSEDES H&V's REFERENCE DATA 47)

Diameter, Inches			Wall Thickness, Inches	Area, Square Inches			Weight per Foot, Pounds			Threads and Tap Drills		
Nominal	Actual Inside	Actual Outside		Of Circle with Outside Diameter	Of Circle with Inside Diameter	Cross-Section of Metal	Of Pipe	Of Water in Pipe	Of Pipe and Water	Threads per Inch	Normal Engagement by Hand of Thread, Inches	Tap Drill Size, Inches
1/8	0.269	0.405	0.068	0.12	0.0569	0.072	0.25	0.028	0.278	27	0.180	11/32
1/4	0.364	0.540	0.088	0.22	0.1041	0.125	0.43	0.045	0.475	18	0.200	7/16
3/8	0.493	0.675	0.091	0.35	0.1909	0.167	0.57	0.083	0.653	18	0.240	37/64
1/2	0.622	0.840	0.109	0.55	0.3039	0.250	0.86	0.132	0.992	14	0.320	45/64
3/4	0.824	1.050	0.113	0.86	0.5333	0.333	1.14	0.232	1.372	14	0.340	29/32
1	1.049	1.315	0.133	1.35	0.8639	0.494	1.68	0.375	2.055	11 1/2	0.400	1 9/64
1 1/4	1.380	1.660	0.140	2.16	1.4950	0.669	2.28	0.649	2.929	11 1/2	0.420	1 1/2
1 1/2	1.610	1.900	0.145	2.83	2.0360	0.799	2.72	0.882	3.602	11 1/2	0.420	1 23/32
2	2.067	2.375	0.154	4.43	3.3560	1.075	3.66	1.454	5.114	11 1/2	0.440	2 3/16
2 1/2	2.469	2.875	0.203	6.49	4.7880	1.704	5.80	2.073	7.873	8	0.680	2 11/16
3	3.068	3.500	0.216	9.62	7.3930	2.228	7.58	3.201	10.781	8	0.770	3 5/16
3 1/2	3.548	4.000	0.226	12.56	9.8880	2.680	9.11	4.287	13.397	8	0.820	3 13/16
4	4.026	4.500	0.237	15.30	12.7300	3.173	10.80	5.516	16.316	8	0.850	4 5/16
5	5.047	5.563	0.258	24.29	20.0100	4.304	14.70	8.674	23.374	8	0.940	5 3/8
6	6.065	6.625	0.280	34.47	28.8900	5.584	19.00	12.520	31.520	8	0.960	6 7/16
8	7.981	8.625	0.322	58.42	50.0300	8.396	28.60	21.680	50.280	8	1.060	8 7/16
10	10.020	10.750	0.365	90.79	78.8500	11.900	40.50	34.160	74.660	8	1.210	10 9/16
12	11.938	12.750	0.406	127.67	113.0900	15.770	53.60	48.500	102.100	8	1.360	12 9/16
14	13.126	14.000	0.437	176.71	135.3200	18.610	63.30	58.640	121.940	8	1.560	13 13/16
16	15.000	16.000	0.500	226.98	176.7200	24.350	82.80	76.580	159.380	8	1.810	15 13/16
18	16.876	18.000	0.562	254.47	223.6800	30.790	105.00	96.930	201.930	8	2.000	17 13/16
20	18.814	20.000	0.593	314.16	278.0000	36.150	123.00	120.460	243.460	8	2.125	19 13/16
24	22.626	24.000	0.687	452.39	402.0700	50.310	171.00	174.230	345.230	8	2.375	23 13/16

Nominal Diameter, Inches	Circumference, Inches		Length of Pipe per Square Foot of Surface		Square Feet of Surface per Foot of Pipe		Capacity of Pipe per Foot of Length		Length of Pipe in Feet to Contain		
	Outside	Inside	Outside, Feet	Inside, Feet	Outside, Sq. Feet	Inside, Sq. Feet	In Cubic Feet	In Gallons	One Cubic Foot	One Gallon	One Pound of Water
1/8	1.27	0.84	9.431	14.15	0.106	0.070	0.00039	0.003	2533.775	338.740	35.7142
1/4	1.69	1.14	7.073	10.50	0.141	0.095	0.00072	0.005	1383.789	185.000	22.2222
3/8	2.12	1.55	5.658	7.67	0.177	0.129	0.00130	0.010	754.360	100.850	12.0482
1/2	2.65	1.95	4.547	6.13	0.221	0.167	0.00210	0.016	473.906	63.356	7.5758
3/4	3.29	2.58	3.637	4.63	0.275	0.215	0.00370	0.028	270.034	36.100	4.3103
1	4.13	3.29	2.904	3.67	0.344	0.274	0.00620	0.045	166.618	22.275	2.6667
1 1/4	5.21	4.33	2.301	2.76	0.435	0.361	0.01040	0.077	96.275	12.871	1.5408
1 1/2	5.96	5.06	2.010	2.37	0.497	0.422	0.01410	0.106	70.733	9.456	1.1338
2	7.46	6.49	1.608	1.84	0.622	0.540	0.02330	0.174	42.913	5.737	.6878
2 1/2	9.03	7.75	1.328	1.54	0.753	0.654	0.03320	0.248	30.077	4.021	.4824
3	10.96	9.63	1.091	1.24	0.916	0.803	0.05140	0.383	19.479	2.604	.3124
3 1/2	12.56	11.14	0.954	1.07	1.047	0.928	0.06820	0.513	14.565	1.947	.2333
4	14.13	12.64	0.848	0.94	1.178	1.052	0.08840	0.660	11.312	1.512	.1813
5	17.47	15.84	0.686	0.75	1.456	1.319	0.13900	1.040	7.198	0.962	.1153
6	20.81	19.05	0.576	0.63	1.734	1.585	0.20100	1.500	4.984	0.666	.0799
8	27.09	25.07	0.443	0.47	2.258	2.090	0.34800	2.600	2.878	0.384	.0461
10	33.77	31.47	0.355	0.38	2.814	2.622	0.54700	4.100	1.826	0.244	.0293
12	40.05	37.70	0.299	0.32	3.370	3.140	0.78500	5.870	1.273	0.170	.0206
14	47.12	44.76	0.250	0.27	3.930	3.722	1.06900	7.030	1.067	0.142	.0171
16	53.41	51.52	0.220	0.23	4.440	4.310	1.39200	9.180	0.814	0.109	.0131
18	56.55	53.00	0.210	0.22	4.712	4.420	1.55300	11.120	0.644	0.086	.0103
20	62.83	59.09	0.190	0.20	5.236	4.920	1.92500	14.400	0.517	0.069	.0083
24	75.40	71.07	0.160	0.17	6.283	5.920	2.80000	20.900	0.357	0.048	.0057

From ASA Standards plus calculated data by J. Lewis Luckenback

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DIMENSIONAL AND CAPACITY DATA OF SCHEDULE 80 PIPE

Welded and Seamless Wrought-Iron and Wrought-Steel Pipe—Schedule 80, American Standards Association B-36-10

Diameter, Inches			Wall Thickness, Inches	Area, Square Inches			Weight per Foot, Pounds			Threads and Tap Drills		
Nominal	Actual Inside	Actual Outside		Of Circle with Outside Diameter	Of Circle with Inside Diameter	Cross-Section of Metal	Of Pipe	Of Water in Pipe	Of Pipe and Water	Threads per Inch	Normal Engagement by Hand of Thread, Inches	Tap Drill Size, Inches
1/8	0.215	0.405	0.095	0.12	0.0363	0.093	0.314	0.0099	0.3239	27	0.180	11/32
1/4	0.302	0.540	0.119	0.22	0.0716	0.157	0.535	0.0310	0.5660	18	0.200	7/16
3/8	0.423	0.675	0.126	0.35	0.1405	0.217	0.738	0.0610	0.7990	18	0.240	37/64
1/2	0.546	0.840	0.147	0.55	0.2341	0.320	1.087	0.1020	1.1890	14	0.320	45/64
3/4	0.742	1.050	0.154	0.86	0.4324	0.433	1.473	0.2130	1.6860	14	0.340	29/32
1	0.957	1.315	0.179	1.35	0.7193	0.639	2.171	0.3120	2.4830	11 1/2	0.400	1 9/64
1 1/4	1.278	1.660	0.191	2.16	1.2830	0.881	2.996	0.5550	3.5510	11 1/2	0.420	1 1/2
1 1/2	1.500	1.900	0.200	2.83	1.7670	1.068	3.631	0.7650	4.3960	11 1/2	0.420	1 23/32
2	1.939	2.375	0.218	4.43	2.9530	1.477	5.022	1.2800	6.3020	11 1/2	0.440	2 3/16
2 1/2	2.323	2.875	0.276	6.49	4.2380	2.254	7.661	1.8300	9.4910	8	0.680	2 11/16
3	2.900	3.500	0.300	9.62	6.6050	3.016	10.252	2.8700	13.1220	8	0.770	3 5/16
3 1/2	3.364	4.000	0.318	12.56	8.8910	3.678	12.505	3.7200	16.2250	8	0.820	3 13/16
4	3.826	4.500	0.337	15.30	11.5000	4.407	14.983	4.9700	19.9530	8	0.850	4 5/16
5	4.813	5.563	0.375	24.29	18.1900	6.112	20.778	7.9400	28.7180	8	0.940	5 3/8
6	5.761	6.625	0.432	34.47	26.0700	8.405	28.573	11.3000	39.8730	8	0.960	6 7/16
8	7.625	8.625	0.500	58.42	45.6600	12.760	43.388	19.8000	63.1880	8	1.060	8 7/16
10	9.564	10.750	0.593	90.79	71.8400	18.920	64.400	31.1300	95.5300	8	1.210	10 9/16
12	11.376	12.750	0.687	127.67	101.6400	26.030	88.600	44.0400	132.6400	8	1.360	12 9/16
14	12.500	14.000	0.750	176.71	122.7200	31.220	107.000	53.1800	160.1800	8	1.560	13 13/16
16	14.314	16.000	0.843	226.98	160.9200	40.140	137.000	69.7300	206.7300	8	1.810	15 13/16
18	16.126	18.000	0.937	254.47	204.2400	50.230	171.000	88.5000	259.5000	8	2.000	17 13/16
20	17.938	20.000	1.031	314.16	252.7200	61.440	209.000	109.5100	318.5100	8	2.125	19 13/16
24	21.564	24.000	1.218	452.39	365.2200	87.170	297.000	158.2600	455.2600	8	2.375	23 13/16

Nominal Diameter, Inches	Circumference, Inches		Length of Pipe per Square Foot of Surface		Square Feet of Surface per Foot of Pipe		Capacity of Pipe per Foot of Length		Length of Pipe in Feet to Contain		
	Outside	Inside	Outside, Feet	Inside, Feet	Outside, Sq. Feet	Inside, Sq. Feet	In Cubic Feet	In Gallons	One Cubic Foot	One Gallon	One Pound of Water
1/8	1.27	0.675	9.431	17.750	0.106	0.0562	0.000326	0.0019	3070.000	527.000	101.0101
1/4	1.69	0.943	7.073	11.920	0.141	0.0785	0.000520	0.0037	1920.000	271.000	32.2581
3/8	2.12	1.328	5.658	9.080	0.177	0.1106	0.000980	0.0073	1370.000	137.000	16.3934
1/2	2.65	1.715	4.547	7.080	0.221	0.1428	0.001620	0.0122	616.000	82.000	9.8039
3/4	3.29	2.330	3.637	4.980	0.275	0.1940	0.003000	0.0255	334.000	39.200	4.6948
1	4.13	3.010	2.904	4.000	0.344	0.2510	0.005000	0.0374	200.000	26.800	3.2051
1 1/4	5.21	4.010	2.301	2.990	0.435	0.3340	0.008800	0.0666	114.000	15.000	1.8018
1 1/2	5.96	4.720	2.010	2.540	0.497	0.3930	0.012300	0.0918	81.500	10.900	1.3072
2	7.46	6.090	1.608	1.970	0.622	0.5070	0.020600	0.1535	49.800	6.520	.7813
2 1/2	9.03	7.320	1.328	1.640	0.753	0.6100	0.029400	0.2200	34.000	4.550	.5464
3	10.96	9.120	1.091	1.310	0.916	0.7600	0.046000	0.3440	21.700	2.910	.3484
3 1/2	12.56	10.580	0.954	1.130	1.047	0.8820	0.061700	0.4580	16.250	2.180	.2688
4	14.13	12.020	0.848	1.000	1.178	1.0020	0.080000	0.5970	12.500	1.675	.2012
5	17.47	15.150	0.686	0.790	1.456	1.2620	0.126000	0.9470	7.950	1.055	.1259
6	20.81	18.100	0.576	0.662	1.734	1.5100	0.182000	1.3550	5.500	0.738	.0885
8	27.09	24.000	0.443	0.502	2.258	2.0000	0.318000	2.3800	3.140	0.420	.0505
10	33.77	30.050	0.355	0.399	2.814	2.5030	0.556000	4.1650	1.800	0.241	.0321
12	40.05	35.720	0.299	0.336	3.370	2.9750	0.706000	5.2800	1.420	0.189	.0227
14	47.12	39.270	0.250	0.305	3.930	3.2710	0.852000	6.3800	1.180	0.157	.0188
16	53.41	44.970	0.220	0.267	4.440	3.7460	1.117000	8.3600	0.895	0.119	.0143
18	56.55	50.660	0.210	0.237	4.712	4.2200	1.418000	10.6100	0.705	0.094	.0113
20	62.83	56.350	0.190	0.213	5.236	4.6940	1.755000	13.1300	0.570	0.076	.0091
24	75.40	67.750	0.160	0.176	6.283	5.6440	2.536000	19.0000	0.395	0.052	.0063

From ASA Standards plus calculated data by J. Lewis Luckenbach

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NEWS OF THE MONTH

51st ASHVE Meeting

NEW YORK—The 51st annual meeting of the American Society of Heating and Ventilating Engineers will be he'd at the Hotel Statler, Boston, Mass., January 22-24, 1945, with members of the Massachusetts Chapter serving as hosts.

Earl G. Carrier, general chairman of the committee on arrangements, has announced the personnel of committees to handle the details of the meeting as follows: committee on arrangements, General Chairman, Earl G. Carrier; Vice-Chairmen, James Holt and David Archer; Advisory Chairman, W. T. Jones; banquet, G. B. Gerrish; finance, J. W. Brinton; transportation, F. R. Ellis; publicity, A. C. Bartlett; entertainment, C. M. F. Peterson; ladies, A. L. Hesselschwerdt, Jr.; reception and registration, P. A. Croney.

Stoker Industry Preparing for Production in Limited Way

CHICAGO—With the release of the amendment to Limitation Order L-75 on mechanical coal stokers by the War Production Board early in October, which permits the resumption of manufacturing of Class B stokers—less than 61 lb of coal per hour—the stoker industry is preparing to start up the production of a very limited quantity of this size machine, according to Marc G. Bluth, executive secretary of the Stoker Manufacturers' Association.

Under a previously WPB approved program, 37,500 residential size stokers have been stipulated as the production quota for the last quarter of this year, the production to be allocated to the manufacturers in the industry based on their percentage of domestic stoker production in 1941. New manufacturers and other firms which had a small stoker production in 1941 or who were not then engaged in stoker manufacturing are included in the allotments.

In reality, Mr. Bluth said, the quota of 37,500 is not expected to be reached before the first of the year. It will first be necessary for every manufacturer located in a critical labor area to secure clearance from the area War Manpower Commission. This means that the large majority of manufacturers must first make application to their local WPB office and if they can show that production of Class B stokers can be resumed without interference with the war effort—that they have manpower and plant facilities available—they probably will be given such permission.

When such permission is granted, the manufacturers will then be able to place orders for materials or to utilize such materials which they have on hand for the production of the small size stokers. However, the industry is facing a serious problem in being able to get into early production because of the scarcity of fractional horsepower motors and foundry castings.

The Association official stated that most manufacturers do not anticipate the production of the small stokers in any quantity until after the first of the year and that in all probability stoker dealers can expect only a very small percentage of their orders to be filled by the middle part of 1945. A limited number of manufacturers, with materials on hand and labor and plant facilities available to them, will probably be able to start shipments of a few domestic stokers within thirty to sixty days, but it will satisfy only a very meager part of the demand from the buying public.

The revision of L-75 also means that effective immediately, it will not be necessary for buyers to make application to WPB for permission to purchase Class A stokers—commercial and small industrial machines. This size stoker, as well as the Class B machine, can now be sold without the necessity of securing priority certificates. A recent amendment to Limitation Order L-41, the construction order, also makes it unnecessary for permission to be secured to purchase the domestic size stokers.

The distribution of both classes of stokers is placed in the hands of the manufacturers. WPB has stated that its policy on distribution is that each manufacturer shall distribute his production through his normal distribution channels, taking into consideration shipments to areas during 1941. However, the War Production Board may direct the distribution of specified amounts from any manufacturer's production to meet emergencies.

Power Show to Feature Plant Equipment

NEW YORK—Equipment for the control and distribution of power will feature the 16th National Exposition of Power and Mechanical Engineering, which opens here the last of this month. The Exposition dates this year run from November 27 to December 2, and it will be held in Madison Square Garden, where the last Power Show was held, two years ago.

Demand for space has heavily taxed the facilities of the largest accessible show place, but by certain rearrangements a 15% increase in the exhibitors' list, as compared with the 1942 Power Show, has been attained.

Attendance at the Exposition, which in pre-war years ran from thirty to forty thousand, non-paying, classified and accredited visitors having a definite connection with power applications, is again expected to approach pre-war levels. Within the five groups of states east of the Mississippi reside major industries which consume 75% of the nation's total of energy wired to manufacturing and extracting plants. New York is within easy traveling distance of this entire area, while the Metropolitan area itself is a heavy consumer of power for industrial applications and provides a substantial proportion of the attendance.

The show is conducted by the International Exposition Company, of which Charles F. Roth, manager of the Exposition, is president.

The Power Show will be open only to visitors having cards of invitation or bearing credentials affirming their connection with power problems and applications. The show will open Monday, November 27, at 2 p.m. and daily thereafter from 11 a.m. to 10 p.m. except Saturday, when the closing hour will be 6 p.m.

New Fuels Research Laboratory

WASHINGTON—An announcement was made by Harold L. Ickes, Secretary of the Interior, that a laboratory will be constructed for the Bureau of Mines at Bruceton, Pa., south of Pittsburgh, for studies of synthetic liquid fuels. The structures comprising the laboratory are expected to be ready for occupancy by the fall of 1945.

The laboratory with its facilities will occupy about 7 acres and will include three large buildings, each three stories high, a power house and several small service buildings. The laboratory will be used to develop improved techniques over that now used in England and Germany.

27,000 New Wells Urged

WASHINGTON, D. C.—A program calling for the drilling of a minimum of 27,000 oil and gas wells next year was recommended by Harold L. Ickes, Petroleum Administrator for War. Of the number recommended, 5,000 would be exploratory wells.

This would call for 3,000 more wells than were scheduled for 1944. While more wells would be desirable to meet the crude oil situation, the number was limited because of manpower shortages and the difficulty of securing materials. The nation's oil fields are now producing more than 5,000,000 barrels of crude oil and other petroleum products daily. This is an all-time high. At the beginning of this year, the war requirements indicated that the need for crude oil would be 4,400,000 barrels daily.

Ralph K. Davies, Deputy Petroleum Administrator, said, "The petroleum industry has fully met the military requirements for petroleum and its products. The unprecedented size of these demands has placed an enormous strain on the productive capacity of the nation's oil fields. To sustain crude oil production at or near present levels, the rate of finding and developing new oil wells must be increased."

Propose Surplus Heating Goods for Slum Clearance

NEW YORK—Use of war surplus heating and plumbing materials for nation-wide reclamation of slum areas is proposed by *Plumbing & Heating Business*, official organ of the National Association of Master Plumbers.

The proposal anticipates considerable unemployment in the building trade during the reconversion period, continuing until construction activity reaches its expected peak level, and suggests that the plan will absorb such unemployment. In addition to giving jobs in the building trade and improving slum conditions, the plan is advanced as a means of disposing of surplus plumbing and heating equipment held by the military services and by Governmental housing agencies.

According to the plan surpluses held by the Government make the future outlook of manufacturers, wholesalers and contractors uncertain. By reserving surpluses for slum rehabilitation, the threat to orderly reconversion of the industry is removed, it is claimed.

Sponsors of the surplus disposal plan are Ralph K. Landreth, president of the National Association of Master Plumbers; Daniel Hayes, president of the Heating, Piping and Air Conditioning Contractors' National Association; and Martin Durkin, president of the United Association of Journeymen Plumbers and Steam Fitters of the United States and Canada.

The plan, as agreed to by these groups, suggests that the contractors establish a fixed fee—below the normal rate—for their supervisory function, and that the journeymen plumbers work at a lower rate than the normal.

To Coordinate House Research

URBANA, ILL. — Post-war small homes will have the benefit of all the past research findings and all the present research facilities of the University of Illinois under formulated plans just announced by Dean Rexford Newcomb of the university's College of Fine and Applied Arts.

The university's small home project is bringing together all of the information gathered by the university in years of research into various aspects of home construction, equipment, and maintenance. The university plans not only to make this assembled information available to the public but to undertake new research activities which may involve the building of specimen homes.

William Scheick, architecture professor and a practicing architect, has been released from teaching duties to coordinate low-cost housing investigations, and bring all of the university's resources to bear upon low-cost housing problems.

University of Illinois research extending back more than a quarter of a century has been carried on in the fields of heating and ventilation, cooling, insulation, building materials, the mechanical equipment of buildings, sewage, plumbing, sanitation, home management, household art, house planning and construction, and rural architecture.

A.S.R.E. to Mark 40th Anniversary

NEW YORK—Program details are being completed for the 40th annual meeting of the American Society of Refrigerating Engineers which will be held December 10-13 at the Hotel Pennsylvania, New York City. It is expected that this will be the largest gathering in the society's history, for in addition to the anniversary, there has been a 40% membership growth the past year.

Honorary membership is to be awarded George A. Horne, past president. On Monday evening, December 11, there will be an Old Timers' Party, and the dinner-dance will be held on the following night. The program, thus far arranged, follows:

MONDAY, DECEMBER 11

2:00 p.m.—First Technical Session
President A. B. Stickney presiding.
"The History of Refrigeration"—Harry Sloan, The Vilter Manufacturing Company, Milwaukee, Wis., past president of the A.S.R.E.
"Heat Operated Refrigerated Cycles"—Dr. R. S. Taylor, Servel, Inc., Evansville, Ind.
Presentation of Honorary Membership in the A.S.R.E. to George A. Horne, past president of the Society.
"Moist Air Research"—Dean John A. Goff, Towne Scientific School, University of Pennsylvania, Philadelphia, Pa.

TUESDAY, DECEMBER 12

9:30 a.m.—Second Technical Session
Vice-President Charles S. Leopold presiding.
"Differential Temperature Expansion Valves"—F. Y. Carter, Detroit Lubricator Company, Detroit, Mich.
"Control of Evaporative Pressures"—Walter A. Grant, Carrier Corporation, Syracuse, New York.
"Pipe Insulation for Steady and Intermittent Refrigeration Service"—W. P. Berggren and R. L. Perry, University of California, Davis, Calif.
12:30 p.m.—A.S.R.E. Welcome Luncheon—Speaker to be announced.
2:00 p.m.—Third Technical Session
Vice-President John F. Stone presiding.
"Home Freezers"—Dr. D. K. Tressler, General Electric Company, Bridgeport, Conn.
"Quick Freezing Performance of an Experimental Sub-Zero Food Freezer"—Prof. J. E. Nicholas, The Pennsylvania State College, State College, Pa.
"The Future of Commercial Freezing"—Richard C. Poole, General Foods Corporation, New York, N. Y.

WEDNESDAY, DECEMBER 13

9:30 a.m.—Fourth Technical Session
Treasurer John G. Bergdoll, Jr., presiding.
"Powder Metallurgy"—A. J. Langhammer, Airtemp Division, Chrysler Corporation, Dayton, Ohio.
"Refrigeration for Penicillin Manufacture"—Clifford F. Holske, The Vilter Manufacturing Company, New York, N. Y.
"Refrigeration as Applied to Lyophilization"—George A. Belsky, Mance Corporation, New York, N. Y.
Installation of officers for 1945.
12:30 p.m.—Luncheon meeting—A.S.R.E. Council.

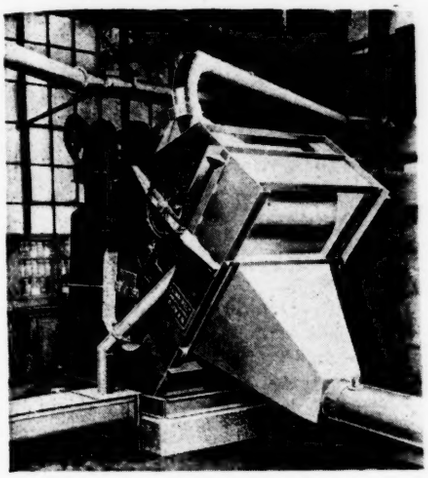
Meetings of the A.S.R.E. Finance, Sections and Executive Committees, and of the A.S.R.E. Council, will be held on Sunday, December 10, preceding the technical sessions, and meetings of various other standing committees are scheduled for Monday morning, December 11.

(Concluded on page 112)

NEWS OF EQUIPMENT AND MATERIALS

Multi-Louvre Dryer

NAME—Link-Belt Multi-Louvre dryer.
PURPOSE—For low cost drying or cooling of bulk materials which do not require long retention periods.



FEATURES—Described as very compact, fully-enclosed unit, containing moving louvers supported on power-operated endless chains. Function of moving louvers is to present material as it flows to secure most efficient drying (or cooling) action. Air which is drawn in through moving mass of material and exhausted at top of dryer can be heated to temperature best suited to material being dried. Ample passages between louvers permit air circulation at low velocity. Fine materials can be carried on the louvers without clogging. The louver-supporting chains are not in path of heated air, neither do they come in contact with material being dried.
LITERATURE AVAILABLE—Folder 2009.
MADE BY—*Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.*

Time-Program Control

NAME—Time-program control available on model 431 Pyromaster potentiometer pyrometer.
PURPOSE—Time-program controllers automatically regulate temperatures, not necessarily at a fixed point, but carry it through a predetermined series of changing values.
FEATURES—Controller can be any of the five air-operated types or several electric types of control manufactured by the company, and in ranges up to 3000F for thermocouple type controllers and up to 3600F when used in connection with the company's compensated radiation unit.
LITERATURE AVAILABLE—Bull. P-1200.
MADE BY—*The Bristol Company, Waterbury 91, Conn.*

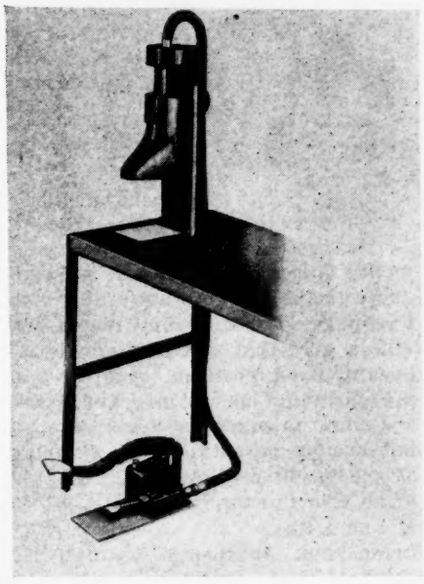
Corrosion Control

NAME—Micromet.
PURPOSE—By the addition of a chemical to the domestic water system, to prevent corrosion in water pipes, tanks, etc.
FEATURES—Since the amount of phosphate to be added to the domestic water system is small, a slowly soluble form of sodium phosphate glass is used. This forms a thin film over the interior surface of water pipes and tanks and resists the attack of oxygen on the metal. Regardless of the amount of water passing over it, it dissolves at the rate of 25% per month. A monthly refill of ¼ pound is sufficient to treat

6,000 gallons water per month, so that scale will be prevented. For the prevention of discolored water, an initial charge of one pound for each 3,000 gallons water is required. A simple feeder can be made from pipe fittings and can be attached to the side of the domestic hot water tank or on the water inlet depending upon the type treatment desired.
MADE BY—*Calgon, Inc., Pittsburgh, Pa.*

Hydraulic Pipe Vise

NAME—Reimuller Hy-speed Press.
PURPOSE—Bench tool for use as pipe vise, testing machine, or a shear for plate or rounds.
FEATURES—Two levers are used in the hydraulic foot control, one to apply pressure up to rated tonnage, and the other for release. Operator's hands are free when operating. Unit is self air eliminating. With proper equipment, press can be used as a



tensile and compression testing unit up to 5 tons, as a pipe vise to handle up to 6 in. pipe, or as a shear for ¼ in. plate.
MADE BY—*Reimuller Brothers Co., 9400 Belmont Ave., Franklin Park, Ill.*

Pocket Slide Rule

NAME—Bruning 2401, 5-inch pocket slide rule.
PURPOSE—To fill need for a high-precision, high-quality pocket slide rule at a moderate price.
FEATURES—A carefully made, smooth-working precision instrument designed for fast, easy operation. Feature is precision of graduations, molded in. Glass indicator is enclosed in a frame of stainless steel.
MADE BY—*Charles Bruning Co., Inc., New York, N. Y.*

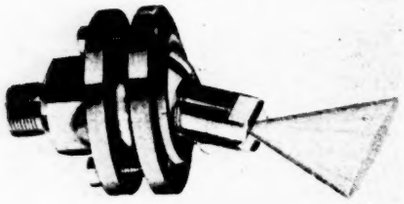
Self-Locking Nut

NAME—Self-locking nut.
PURPOSE—To provide an all metal self-locking nut for precision fastening.
FEATURES—No cotter pins or wiring is needed. Said to have ability of withstanding high temperatures. Self-locking feature does not injure either the bolt or nut thread.
MADE BY—*Dzus Fastener Co., Inc., Babylon, N. Y.*

Ball and Socket Joint

NAME—Spraying systems adjustable joint.

PURPOSE—A ball and socket joint to provide a full 50 deg. nozzle adjustment range in any plane at right angle to the face of the joint.



FEATURES—Thick socket plates provide a grip that can hold the nozzle in any fixed position, regardless of the spraying operation. The standard joint is made in brass or steel, but it may be obtained in a variety of special steel alloys.

SIZES AND CAPACITIES—⅛, ¼, ⅜, ½, ¾ and 1 in.

LITERATURE AVAILABLE—Catalog No. 22 of 32 pages on spray nozzles and related products.

MADE BY—*Spraying Systems Co., 4031 West Lake St., Chicago 24, Ill.*

pH Determination

NAME—Lumetron Colorimeter—Model 400.

PURPOSE—A photoelectric means for determining the acid or the alkaline properties of a substance.

FEATURES—The instrument is housed in a portable wooden case. The whole pH range, including the highest alkalinity, can be covered without any danger of damage to costly parts. This instrument simplifies the making of pH determinations. Another model, 400-S, is designed for a continuous reading of a solution flowing through the instrument. There is an assortment of indicator solutions for various pH ranges.

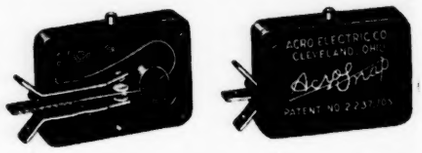
MADE BY—*Photovolt Corp., 95 Madison Ave., New York 16, N. Y.*

Small Snap-Action Switch

NAME—Miniac.

PURPOSE—Said to be smallest fully enclosed snap-action switch ever built.

FEATURES—Switch is 17/64 in. thick, 13/16 in. high, and 1 3/16 in. long. Engineered on the rolling spring principle, but with new design and smaller size. Fully enclosed in bakelite case with four mounting holes 3/32 in. diameter. Actuation is with a stainless steel pin plunger. All parts are non-corrosive and all contacts are of fine silver. Main blade, contact blade, and rolling spring made of beryllium copper. Rated at 15 amp., 115 volts A.C. Furnished in single pole, normally open and normally closed, double throw. Designed to permit leaf type or overtravel plunger type actuators to be attached to the case.



MADE BY—*Acro Electric Co., 1391 Superior Ave., Cleveland 14, Ohio.*

Floquil Marker

NAME—Floquil fountain marker.

PURPOSE—For markings on all types of materials including wood, paper, glass, rubber, metals and textiles.

FEATURES—Marker consists of three non-moving parts with 12 easily interchangeable nibs. Seven transparent colors are available for use with the marker.

MADE BY—*Floquil Products, Inc., 1974 Broadway, New York 23, N. Y.*

Decals for Fire Extinguishers

NAME — Decalcomanias for first-aid fire extinguishers.

PURPOSE—To indicate the type of fire for which extinguisher is to be used.

FEATURES — Correct marking of extinguishers with these decals will direct the untrained or excited employe to the proper extinguisher.

DISTRIBUTED BY—A limited number of sets will be distributed *free.* Larger quantities will be sent for a nominal charge. Write to *Walter Kidde & Co., Inc., New York 6, N. Y.*

Welding Electrode Holder

NAME—Type INS holder for welding electrodes.

PURPOSE — Holder lighter in weight than existing ones, and also cheaper in cost.

FEATURES—Holder has a current rating of 300 amperes and it can handle electrodes from 1/16 to ¼ in. diameter. Trigger is of molded, heat-resisting inorganic material. It has a hollow, air-cooled, heat-resisting fibre hand e, and gives equally good performance on a-c or d-c current. Holder can hold the electrode securely at any angle.

MADE BY—*Lincoln Electric Co., Cleveland, Ohio.*

Fireplace Grate

NAME—Verti-grate.

PURPOSE—For heating rooms with fireplaces, when house heating system is not operating.

FEATURES — Grate is made of cast iron with special heat-refracting lining on the back and sides. It has top doors for fueling and a rocker shaker for cleaning ashes. Tall grate, narrow in depth is claimed to provide more heat than the conventional horizontal grate.

MADE BY—*Centre Brass Works, Inc., 2323 Haviland Ave., New York 61, N. Y.*

Insulation Compound

NAME—Cell-Tite.
PURPOSE — Sponge rubber compound that can be used for insulation, moulded into sheets, or into definite forms.

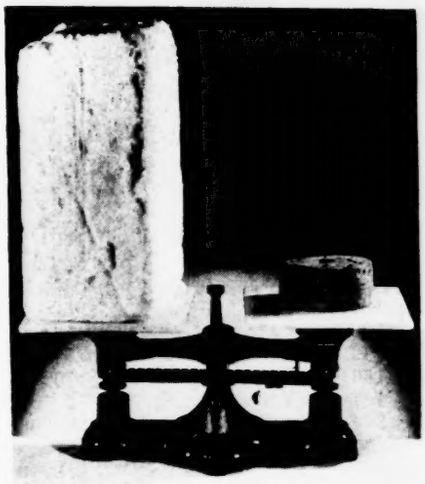
FEATURES — Compound made from Buna N rubber is suitable for use from —60F to 200F. Thermal conductivity for 8 lb per cu ft density ranges from 0.25 to 0.30 Btu per hour per sq ft per in. thickness. It is resistant, it is said, to the common chemicals, particularly the common oils and solvents. It is vermin proof and has good aging qualities. A soft form of this compound can be used for door seal or gasket, or as a motor block. Its use as an insulation for a cold pipe is illustrated.
MADE BY—*The Sponge Rubber Products Co., Shelton, Conn.*

Program Timer

NAME—Zenith program timer.
PURPOSE—To send signals or electric impulses at any 5-minute period throughout the day.
FEATURES—Small spring brass clips are inserted in slots of the program disc for the program of signals desired. Operation is performed by a set of cam-operated contacts. Silver contacts operate with snap action. As many as 288 operations a day are possible, and circuit closures can be from 5 to 60 seconds at the time specified. Steel case is 8 x 12 x 4 in., and the rating is 10 amperes at 110 volts.
MADE BY—*Zenith Electric Co., 152 W. Walton St., Chicago 10, Ill.*

Foam Insulator

NAME—Flotofoam.
PURPOSE—For use as insulation in homes, trains, cars, and for buoyancy units on pleasure craft.
FEATURES — It has great buoyancy and is semi-rigid. The makers claim it has good insulation and sound-deadening properties. It weighs less than 1.5 lb per cu ft and this weight



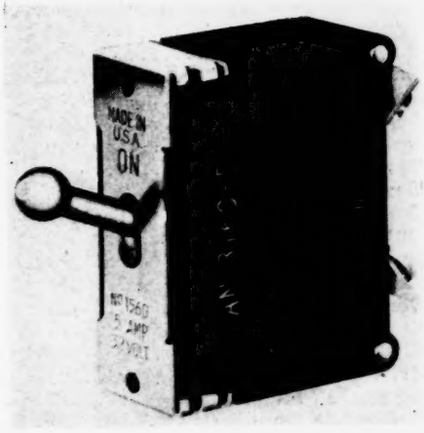
can be reduced to ¾ lb for the same unit. Photo shows how much lighter this material is than cork.
MADE BY—*United States Rubber Co., Rockefeller Center, New York, N. Y.*

Plastic Insulated Wire

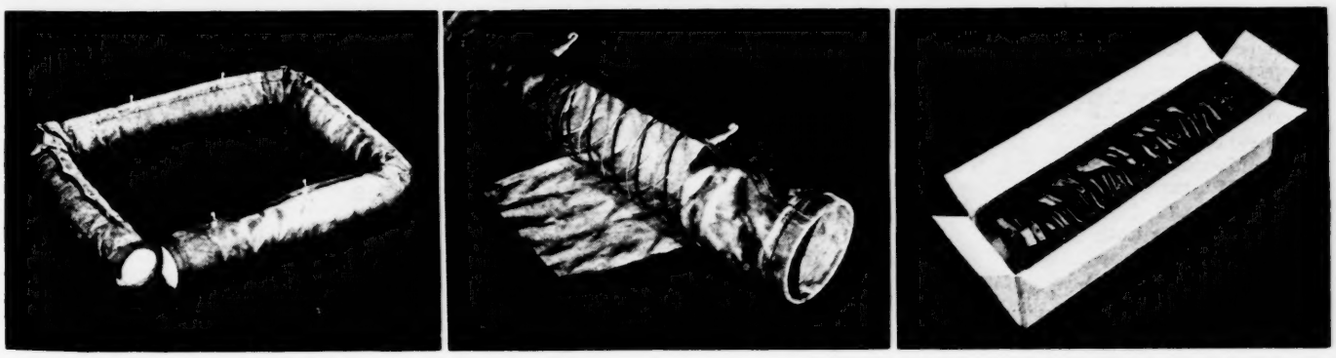
NAME—Deltabeston Flamenol.
PURPOSE—Insulated lead wire for use in all types of fluorescent lamp ballasts.
FEATURES—This thermo-plastic insulated wire is approved by the Underwriters' Laboratories for use as lead wire in lighting fixtures where 600 volt service is required. Insulation is superaging and is resistant to flame, oils, acids and alkalies. It is approved for 176F. Insulated wire is free stripping and easy to splice.
MADE BY—*General Electric Co., 1285 Boston Ave., Bridgeport 2, Conn.*

Switch Breaker

NAME—Littlefuse switch breaker.
PURPOSE—For opening electric circuits when high temperature is reached at the switch.
FEATURES—A bi-metal finger trips the breaker at the proper temperature. This makes possible its use for starting motors at high load without tripping the breaker. The time lag makes it also suitable for use with other equipment having high starting surge currents.
SIZES—5 to 50 amperes at 32 volts, either ac or dc.



MADE BY—*Littlefuse, Inc., 200 Ong St., El Monte, Calif., and 4757 Ravenswood Ave., Chicago 40, Ill.*



Views of Du Pont Ventube showing left, the non-collapsible helical type duct as opened for industrial ventilation. The spring prevents kinking and loss of air when tubing is sharply bent. Center, cutaway, shows the helical spring, and the right view shows the duct folded at a ratio of 15 ft. to 20 in. for easy storage. Description, with no illustrations, was included in last month's issue. Maker, E. I. Du Pont de Nemours & Co., Inc., Empire State Bldg., New York, N. Y.

Degree-Days for September, 1944

HEATING AND VENTILATING'S 16th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Sept., 1944	Degree-Days, Sept., 1943	Degree-Days, Sept., Normal	Season, 9/1/44-9/30/44	Season, 9/1/43-9/30/43	Season, Normal, 9/1-9/30	Normal, 9/1-6/30
Abilene, Texas	0	8	0	0	8	0	2061
Albany, New York	127	190	72	127	190	72	6580
Albuquerque, New Mexico	21	14	0	21	14	0	4298
Alpena, Michigan	220	302	222	220	302	222	8299*
Anaconda, Montana	307	224	335	307	224	335	8357**
Asheville, North Carolina	(a)	114	0	(a)	114	0	4232
Atlanta, Georgia	4	23	0	4	23	0	2890
Atlantic City, New Jersey	31	69	0	31	69	0	5176
Augusta, Georgia	0	1	0	0	1	0	2161
Baker, Oregon	217	114	258	217	114	258	7163
Baltimore, Maryland	27	54	0	27	54	0	4533
Billings, Montana	192	169	189	192	169	189	7119
Binghamton, New York	122	195	108	122	195	108	6808
Birmingham, Alabama	0	20	0	0	20	0	2352
Bismarck, North Dakota	233	229	222	233	229	222	9192
Block Island, Rhode Island	59	89	0	59	89	0	5788
Boise, Idaho	130	37	102	130	37	102	5552
Boston, Massachusetts	90	120	48	90	120	48	6045
Bozeman, Montana	281	263	336	281	263	336	8521**
Buffalo, New York	119	191	75	119	191	75	6822
Burlington, Vermont	173	230	144	173	230	144	7514
Butte, Montana	344	295	344	344	295	344	8272
Cairo, Illinois	0	37	0	0	37	0	3909
Canton, New York	202	268	189	202	268	189	8020
Charles City, Iowa	132	246	93	132	246	93	7588
Charleston, South Carolina	0	0	0	0	0	0	1769
Charlotte, North Carolina	8	36	0	8	36	0	3120
Chattanooga, Tennessee	1	24	0	1	24	0	3118
Cheyenne, Wyoming	236	225	240	236	225	240	7466
Chicago, Illinois	77	167	0	77	167	0	5957
Cincinnati, Ohio	41	88	0	41	88	0	4684
Cleveland, Ohio	90	134	27	90	134	27	6155
Columbia, Missouri	32	82	0	32	82	0	4922
Columbia, South Carolina	3	7	0	3	7	0	2364
Columbus, Ohio	53	111	0	53	111	0	5398
Concord, New Hampshire	169	246	168	169	246	168	7353
Concordia, Kansas	46	62	0	46	62	0	5315
Dallas, Texas	0	1	0	0	1	0	2256
Davenport, Iowa	52	136	0	52	136	0	6289
Dayton, Ohio	54	130	0	54	130	0	5264
Denver, Colorado	87	93	72	87	93	72	5874
Des Moines, Iowa	70	160	0	70	160	0	6384
Detroit, Michigan	91	171	42	91	171	42	6490
Devils Lake, North Dakota	275	311	276	275	311	276	9970
Dodge City, Kansas	57	44	0	57	44	0	5035
Dubuque, Iowa	83	191	36	83	191	36	6790
Duluth, Minnesota	279	374	270	279	374	270	9443
Eastport, Maine	222	277	276	222	277	276	8520**
Elkins, West Virginia	139	215	63	139	215	63	5697
El Paso, Texas	0	14	0	0	14	0	2428
Ely, Nevada	(a)	170	(a)	(a)	170	(a)	(a)
Erie, Pennsylvania	(a)	137	36	(a)	137	36	6273
Escanaba, Michigan	213	343	243	213	343	243	8771*
Evansville, Indiana	21	84	0	21	84	0	4244
Forth Smith, Arkansas	0	0	0	0	0	0	3147
Fort Wayne, Indiana	101	203	0	101	203	0	5925
Fort Worth, Texas	0	3	0	0	3	0	2148
Fresno, California	1	0	0	1	0	0	2334
Galveston, Texas	0	0	0	0	0	0	1016
Grand Junction, Colorado	6	2	0	6	2	0	5548
Grand Rapids, Michigan	100	188	57	100	188	57	6535
Green Bay, Wisconsin	163	272	132	163	272	132	7825
Greensboro, North Carolina	24	68	0	24	68	0	3529
Greenville, South Carolina	13	33	0	13	33	0	3380
Harrisburg, Pennsylvania	59	109	0	59	109	0	5375
Hartford, Connecticut	87	129	48	87	129	48	6036
Hatteras, North Carolina	1	6	0	1	6	0	2571
Havre, Montana	197	231	270	197	231	270	8700
Helena, Montana	268	226	251	268	226	251	7898
Houston, Texas	0	2	0	0	2	0	1157
Huron, South Dakota	158	209	123	158	209	123	8004
Indianapolis, Indiana	34	112	0	34	112	0	5298
Kansas City, Missouri	23	60	0	23	60	0	4956
Kewanee, Illinois	41	170	78	41	170	78	6139
Knoxville, Tennessee	1	44	0	1	44	0	3670
La Crosse, Wisconsin	111	251	96	111	251	96	7322
Lander, Wyoming	249	191	276	249	191	276	7947

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

[2]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with eight exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, and Sioux City, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill., and Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table concluded on page 100]

RUGGED

The ability of Tube-Turn welding fittings to withstand severe shocks, such as "water hammer" or impact at sub-zero temperatures, is determined *before* they are made. The most modern and accurate machines are used to make izod, tension impact and Charpy tests on materials from which Tube-Turn fittings shall be forged. All tests taken vertify that ruggedness — just downright *toughness* — is *built into* every Tube-Turn fitting by a combination of superior metals, proved designs and exclusive forging processes. Be sure, when designing or repairing piping systems, to use fittings from the [illegible]ns Catalog, and to insist on these *original* [illegible]g fittings in all specifications.

Selected Tube Turns Distribu[illegible]n every principal city are ready to serve you from complete stocks.

TUBE TURNS (Inc.) Louisville, Kentucky. Branch Offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle, Los Angeles.

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Latest engineering data, exclusive charts, helpful diagrams and tables . . . all in one easy-to-use 240 page volume! Write (on letterhead) for Tube Turns Catalog Number 111.

ARMY E NAVY M

TUBE-TURN

TRADE MARK

Welding Fittings and Flanges

Degree-Days for September, 1944 (Concluded)

HEATING AND VENTILATING'S 16th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Sept., 1944	Degree-Days, Sept., 1943	Degree-Days, Sept., Normal	Season, 9/1/44-9/30/44	Season, 9/1/43-9/30/43	Season, Normal, 9/1-9/30	Normal, 9/1-6/30
Lansing, Michigan	154	255	114	154	255	114	7048
Lewiston, Maine	186	261	165	186	261	165	7707
Lincoln, Nebraska	57	84	0	57	84	0	5999
Little Rock, Arkansas	0	3	0	0	3	0	2811
Livingston, Montana	308	213	227	308	213	227	7205
Los Angeles, California	5	0	0	5	0	0	1504
Louisville, Kentucky	16	61	0	16	61	0	4180
Lynchburg, Virginia	37	66	0	37	66	0	3980
Macon, Georgia	0	7	0	0	7	0	2201
Madison, Wisconsin	111	243	87	111	243	87	7429
Marquette, Michigan	244	334	225	244	334	225	8693*
Memphis, Tennessee	0	21	0	0	21	0	2950
Meridian, Mississippi	0	3	0	0	3	0	2160
Milwaukee, Wisconsin	82	235	84	82	235	84	7245
Minneapolis, Minnesota	134	236	93	134	236	93	7850
Modena, Utah	101	64	156	101	64	156	6562
Montgomery, Alabama	0	0	0	0	0	0	1884
Nantucket, Massachusetts	59	103	63	59	103	63	5957
Nashville, Tennessee	1	36	0	1	36	0	3507
New Haven, Connecticut	75	111	39	75	111	39	5895
New Orleans, Louisiana	0	0	0	0	0	0	1024
New York, New York	35	65	0	35	65	0	5347
*Nome, Alaska	503	534	600	503	13514	13658	14580**
Norfolk, Virginia	5	27	0	5	27	0	3350
North Head, Washington	224	208	255	224	208	255	5452**
North Platte, Nebraska	94	110	42	94	110	42	6366
Oakland, California	97	62	90	97	62	90	3143**
Oklahoma City, Oklahoma	10	1	0	10	1	0	3613
Omaha, Nebraska	62	108	0	62	108	0	6131
Oswego, New York	133	194	114	133	194	114	7088
Parkersburg, West Virginia	58	104	0	58	104	0	4775
Peoria, Illinois	69	151	3	69	151	3	6109
Philadelphia, Pennsylvania	31	49	0	31	49	0	4855
Phoenix, Arizona	(a)	0	0	(a)	0	0	1405
Pittsburgh, Pennsylvania	64	112	0	64	112	0	5235
Pocatello, Idaho	203	86	156	203	86	156	6655
Portland, Maine	192	240	162	192	240	162	7218
Portland, Oregon	80	30	105	80	30	105	4469
Providence, Rhode Island	61	112	63	61	112	63	6015
Pueblo, Colorado	67	90	6	67	90	6	5514
Raleigh, North Carolina	5	39	0	5	39	0	3234
Rapid City, South Dakota	149	169	144	149	169	144	7118
Reading, Pennsylvania	50	90	0	50	90	0	5389
Redding, California	(a)	0	0	(a)	0	0	2451
Reno, Nevada	149	53	144	149	53	144	5892
Richmond, Virginia	16	46	0	16	46	0	3695
Rochester, New York	134	193	72	134	193	72	6732
Roseburg, Oregon	73	27	111	73	27	111	4428
Roswell, New Mexico	19	18	0	19	18	0	3484
Sacramento, California	3	0	0	3	0	0	2653
St. Joseph, Missouri	36	75	0	36	75	0	5161
St. Louis, Missouri	17	56	0	17	56	0	4585
Salt Lake City, Utah	67	26	18	67	26	18	5555
San Antonio, Texas	0	10	0	0	10	0	1202
San Diego, California	6	0	0	6	0	0	1645
Sandusky, Ohio	71	121	0	71	121	0	6208
San Francisco, California	149	101	114	149	101	114	3264**
Sault Ste. Marie, Michigan	281	351	276	281	351	276	9285**
Savannah, Georgia	0	0	0	0	0	0	1490
Scranton, Pennsylvania	107	157	60	107	157	60	6129
Seattle, Washington	93	81	186	93	81	186	4934**
Sheridan, Wyoming	209	238	264	209	238	264	8008
Shreveport, Louisiana	0	1	0	0	1	0	1938
Sioux City, Iowa	117	162	33	117	162	33	6898
Spokane, Washington	152	92	192	152	92	192	6355
Springfield, Illinois	30	82	0	30	82	0	5373
Springfield, Missouri	29	84	0	29	84	0	4428
Syracuse, New York	135	209	96	135	209	96	6893
Tacoma, Washington	127	129	207	127	129	207	5181**
Terre Haute, Indiana	35	105	0	35	105	0	4872
Toledo, Ohio	103	194	9	103	194	9	6077
Topeka, Kansas	26	44	0	26	44	0	4969
Trenton, New Jersey	49	88	0	49	88	0	4933
Utica, New York	151	225	182	151	225	182	6796
Valentine, Nebraska	144	166	93	144	166	93	7039
Walla Walla, Washington	65	13	30	65	13	30	4808
Washington, D. C.	24	64	0	24	64	0	4626
Wichita, Kansas	30	18	0	30	18	0	4673
Williston, North Dakota	241	262	270	241	262	270	9323
Winnemucca, Nevada	166	28	192	166	28	192	6427**
Yakima, Washington	79	18	120	79	18	120	5599

*Includes August. **Includes July and August. (a) Data not available.

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

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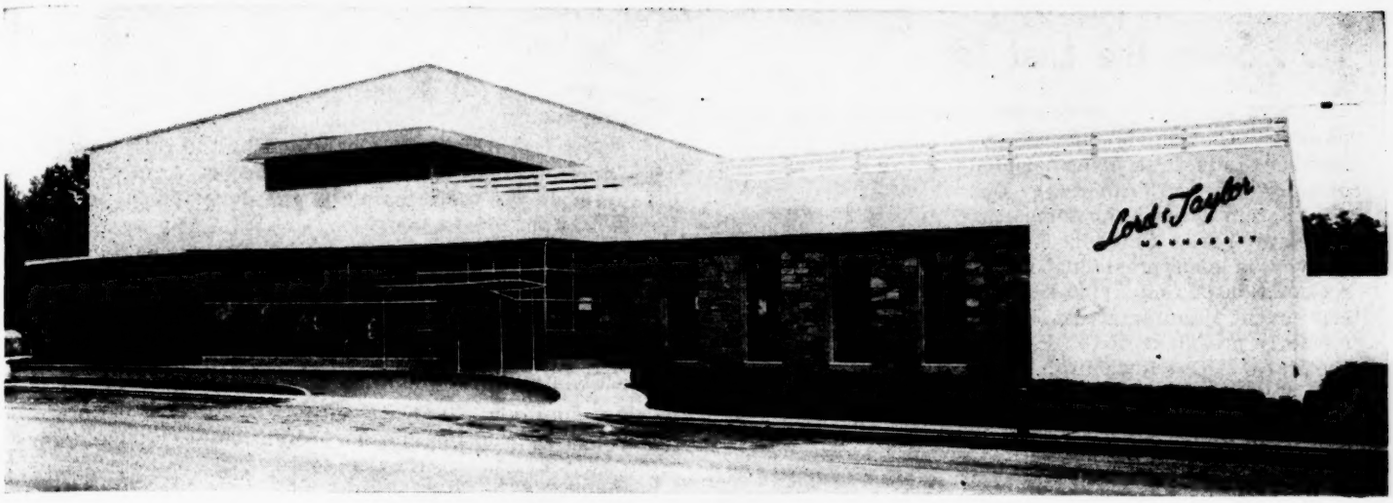
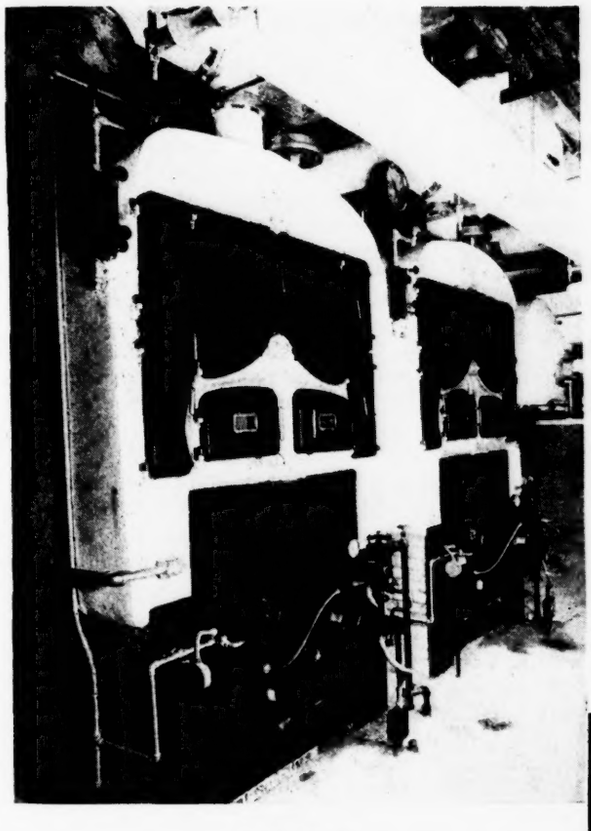


Boiler Plant... FOR THE POST-WAR DEPARTMENT STORE



Boiler Room
Two "44 Mills" oil-fired H. B. SMITH Boilers

Architects and engineers who are now confronted with the specification of mechanical equipment for department stores to be built post-war will do well to consider those installations in like projects erected immediately pre-war to find the answers to their most compelling problems.

It is our prediction that as far as heat generation is concerned the boiler plants in tomorrow's stores will closely resemble their 1941 counterparts.

Take Lord & Taylor's new Manhasset, L. I. shop, for example. Here is a worthy model for post-war planners. The heating system includes complete equipment for providing year round air treatment as well as accurate control of both the heating and climatic conditions expected by today's department store customers. Consulting engineer, Edward Ashley, specified two No. "44 Mills" oil-fired H. B. SMITH boilers for this job not only for their efficient operation, but because of their unusual flexibility of performance so necessary to this type of system.

With many installations like Lord & Taylor's a matter of record, it is possible to eliminate at least one intangible in your planning, for you can *today* specify a known quantity in boiler performance . . . H. B. SMITH.

THE H. B. SMITH CO., INC., WESTFIELD, MASS.
Branch Offices and Sales Representatives in principal cities

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CAST-IRON BOILERS

Main Stairway and Dress Salon

. . . Since the Last Issue

Lyle C. Harvey, president of the **Bryant Heater Company** of Cleveland, one of the Dresser Industries, was elected director of the **American Gas Association** at its annual meeting in New York, October 5. Mr. Harvey is also president of the Association of Gas Appliance and Equipment Manufacturers. He was formerly president of the Peoples Natural Gas Co., Pittsburgh.

Lyle C. Harvey

J. French Robinson, president of the **East Ohio Gas Company,** Cleveland, was elected president of the American Gas Association at the meeting referred to above.

Election of **Ellis L. Spray** as vice-president and general manager of the **Westinghouse Electric Elevator Company,** subsidiary of the **Westinghouse Electric and Mfg. Company,** is announced. Mr. Spray's election follows the retirement of Frank C. Reed who had been president of the Elevator Company since 1936 and a vice-president of the parent company since 1942. George H. Bucher, president of Westinghouse, was recently elected president of the Elevator Company.

Plans are being made for the 1945 Foundry Congress and the 49th annual meeting of the **American Foundryman's Association** to be held in Detroit, April 30-May 4. No exhibit is planned in connection with the Detroit meeting.

The Foxboro Company, Foxboro, Mass., announces the addition of **Frank Renner** to the staff of sales engineers covering the Southern California territory. His headquarters are at Foxboro's office in Los Angeles, 2307 East 8th St., (21). He has had nearly 20 years of industrial experience, and is especially familiar with the engineering problems involved in the production of oil and gas.

Robert Beers has joined the staff of sales engineers attached to the New York Office of The Foxboro Company, and has already taken up his duties in the New York-New Jersey territory. The New York Office is at 420 Lexington Ave., (17). After graduating from Yale (Sheffield) in 1924, Mr. Beers spent several years in the production department of the Western Electric Co., followed by similar experience with the American Brass Co., and Whitehead Metal Products. For the past two years he has been with the WPB at Washington, handling problems in the metallurgical field.

John Hoffman, formerly assistant manager of the Portland, Ore., office, **J. O. Ross Engineering Corporation, has** been promoted to the rank of Major. Major Hoffman, who has served throughout the Italian Campaign with an outfit attached to the Fighting French, has had the added honor of being decorated with the famous Croix de Guerre.

McCord Radiator & Mfg. Co., Detroit, Mich., announces change of name to **McCord Corporation,** effective September 29, 1944.

Air Devices, Inc., 17 E. 42nd St., New York, announces the election of three new officers, with **C. N. O'Day,** one of the company's founders and previously its treasurer, assuming the presidency. **Gerald F. Mannion** becomes the company's vice-president, and **George J. Sweeney** the new treasurer.

The reorganization is occasioned by the retirement of the former president, Jack Spalding, Jr., from the company to devote his full time to the development of food dehydration.

Mr. O'Day has been associated with the heating and ventilating field for 30 years. He previously was designer, chief engineer, and sales manager of the Buckeye Blower Co., and was connected with the eastern sales division of Barber-Colman Co. prior to his joining Mr. Spalding in the founding of Air Devices, Inc. in 1939.

Mr. Mannion has been actively connected with the heating, ventilating and air conditioning industry for the past 22 years. Eleven years were spent as sales manager for Chicago Pump Company, during which time he organized and developed that company's national selling organization.

C. E. Lund has been appointed Director of Research by the **Seeger Refrigerator Company,** Saint Paul, Minn.

Mr. Lund has been in the refrigeration and air conditioning field since graduating from the University of Minnesota as a Bachelor of Mechanical Engineering. He also holds a degree of Master of Science in Mechanical Engineering.

His previous position was Associate Professor and Assistant Director of the Engineering Experimental Station, University of Minnesota, where he worked in cooperation with Professor F. B. Rowley, Director of the Engineering Experiment Station, and Dr. R. C. Jordan, Associate Professor and Director of Industrial Engineering Laboratories. Together Mr. Lund and Dr. Jordan developed the refrigeration laboratory of the University of Minnesota and formulated the course in applied refrigeration which is sponsored by the U. S. Office of Education under the Engineering Science Management War Training Program.

C. E. Lund

In 1937 he was Research Engineer of the University of Minnesota in charge of Cooperative Industrial Research under Professor F. B. Rowley, specializing in the study of moisture and vapor transmission through insulation.

Laurence E. Cooney has been appointed vice-president and general sales manager of **The Austin Company.** Mr. Cooney has been associated with The Austin Company for more than 25 years, joining the organization in 1919. His first position was assistant to the general construction manager and he served successively as office manager; assistant district construction superintendent; district construction superintendent; assistant to the executive vice-president. In 1927, he was made Cleveland district sales manager and two years later assistant district manager; 1932, district sales manager. From 1941 to 1943, he was the project manager on Bell Aircraft Corporation's construction and in 1943 returned as district sales manager.

A. A. Kucher, director of research, **Bendix Aviation Corp.,** and chairman of its long-range planning committee, has been elected vice-president of the corporation.

(Continued on page 104)

CHECK ✓ AND DOUBLE CHECK ✓ ✓

IN EVERY STAGE OF PURCHASE AND PRODUCTION COUNTLESS TESTS ASSURE DEPENDABILITY OF WHITE-RODGERS CONTROLS

The accuracy and dependability of White-Rodgers temperature and pressure controls begins *when materials enter the factory.*

Every part, every assembly is checked and double checked to make sure it will perform the function for which it was designed.

These preliminary tests plus the rigid final inspection of the finished White-Rodgers control are reflected in the performance of your own equipment.

Write for your copy of the White-Rodgers catalog today!

Checking concentricity between thread diameter and outside diameter of unit nut—held to close tolerance for proper calibration.

Electrically and mechanically checking spring pressure to assure complete range of control operation.

Checking form of gear teeth and relation to shaft assembly over entire circumference by exacting comparator method.

8 EXCLUSIVE FEATURES OF WHITE-RODGERS HYDRAULIC-ACTION TEMPERATURE CONTROLS

1. May be mounted at any angle or position, above, below or on level with control point.

2. Hydraulic-Action Principle incorporating solid-liquid filled bulb and capillary provides expansion force comparable to that of a metal bar.

3. Diaphragm motion uniform per degree of temperature change.

4. Power of solid-liquid charge permits unusually sturdy switch construction resulting in positive contact closure.

5. Heavier, longer-wearing parts are possible because of unlimited power.

6. Dials are evenly and accurately calibrated over their entire range because of straight-line expansion.

7. Controls with remote bulb and capillary are not sensitive to change in room temperature. Accuracy of control is not affected by temperature changes in surrounding area.

8. Not affected by atmospheric pressure. Works accurately at sea level or in the stratosphere without compensation or adjustment.

WHITE-RODGERS ELECTRIC CO.

1207L Cass Ave. St. Louis, Mo.

Controls for Refrigeration • Heating • Air-Conditioning

(Continued from page 102)

Louis R. Schneider has been appointed general manager of **Philco Distributors, Inc.,** Newark division. **Albert K. Spears** was named General Sales Manager. The new division with headquarters at 1060 Broad St., Newark, will handle, among other things, refrigerators and air conditioners.

The **Badger Mfg. & Sales Company,** Milwaukee, Wis., manufacturers of filters, has changed its corporate name to **Badger Corporation.** There is no change in the officers or personnel. The Company is located at 327 East Brown St., Milwaukee 12.

H. K. Porter Company, Inc., Pittsburgh, Pa., has appointed **Victor Failmezger,** previously application and field engineer for the company, to the position of sales manager of its subsidiary, Quimby Pump Company, of Newark and New Brunswick, N. J.

Victor Failmezger

Mr. Failmezger is a graduate of Stevens Institute of Technology with degree of Mechanical Engineer. He was associated with Westinghouse Electric & Mfg. Co., and Worthington Pump Co. in both sales and application engineering in the 15 years prior to joining the Porter organization. During the past year, Mr. Failmezger has represented Porter and its subsidiaries in Western Pennsylvania, West Virginia, and Eastern Ohio.

The resignation of **J. W. Baillie,** secretary and Treasurer of the Detroit Lubricator Company, has been announced by C. H. Hodges, president, effective December 1, 1944. On that date Mr. Baillie will become active president of the **American Gas Machine Company,** Albert Lea, Minn., on whose board of directors he has served for the past three years and in this capacity has been in close touch with the company's various activities.

Walter A. Meyer, Allis-Chalmers manager of dealer sales, has been elected president of the Multiple V-Belt Drive Association at its meeting in Cleveland. Other officers of the association are **William D. Hamerstadt,** Indianapolis, Ind., vice-president, and **A. B. Anderson,** Chicago, Ill., secretary-treasurer.

Walter Sormane has been appointed general sales manager of **Conco Engineering Works,** Mendota, Ill. Mr. Sormane recently resigned as sales manager of Schwitzer-Cummins Co., Indianapolis, after being associated with that company for 12 years. His appointment coincides with Conco's recent announcement of the company's re-entry into the heating business after a two-year leave of absence. Since the start of the war, Conco's entire manufacturing facilities and efforts were directed towards the production of war material.

Walter Sormane

George E. Simons has been appointed Advertising and Sales Promotion Manager of the **General Electric Air Conditioning and Commercial Refrigeration Divisions** effective October 16.

Four organizational appointments in connection with post-war expansion plans were made by **Drayer & Hanson, Inc.,** Los Angeles, manufacturers of heat exchange equipment.

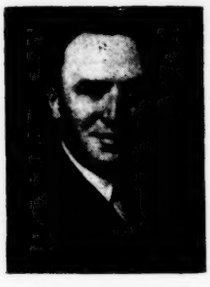
Albert Hanson has been promoted to the position of vice-president in charge of engineering. **J. C. Lombardi,** who has been in special sales capacities for a number of years, has been appointed as vice-president, director of sales. **Scott M. Hauser,** vice-president, becomes director of sales promotion and advertising. **A. H. Witt,** who has also been in special sales work for the corporation during the war period, has been promoted to the position of air conditioning and refrigeration sales manager.

Willis Stafford has been appointed to the field organization of the **Herman Goldberg Co.** Before joining Goldberg staff, Mr. Stafford resigned his post as assistant chief instructor at Commercial Traders Institute, Bloomington, Ill., where he trained U. S. Army Quartermaster Corps personnel to maintain army refrigeration equipment. Previously he was connected with the Detroit Lubricator Company as a field engineer.

Combustioneer Division of The Steel Products Engineering Co. of Springfield, Ohio, has made three new executive appointments. **C. P. Meredith** has been made general sales manager for the Combustioneer stoker division and will head up the division's expanded selling

H. E. McCampbell

C. G. Brelsford



C. P. Meredith

organization. Until recently, Mr. Meredith was executive assistant in charge of Post-war Development; **H. E. McCampbell** has been appointed commercial sales manager of the division. Since 1931 he has been manager of the service department; **C. G. Brelsford** will be manager of the service department. Mr. Brelsford was transferred to the stoker division from the mechanical department of the company. For the past several years he has been traveling service engineer.

Latest addition to the executive staff of **Hammel Radiator Engineering Co.,** Los Angeles, is **Fay Suffron,** former member of the research staff of American Gas Association. Mr. Suffron joins the organization as its research engineer. He formerly served with the Portland Gas and Coke Company, Portland, Oregon, and the Washington Gas and Electric Company at Tacoma. For ten years he was on the staff of the AGA Testing Laboratories, first at Cleveland, and later at Los Angeles where he acted as supervisor of the Laboratory.

Lawler Automatic Controls, Mount Vernon, N. Y., has appointed **Refrigerating & Power Specialties Co.,** San Francisco, and **J. E. Fowler, Jr.,** 4306 Anderson Ave., Chattanooga 4, Tenn., as factory representatives for northern California and Tennessee, Georgia and Alabama, respectively.

(Continued on page 106)

AIRTHERM Efficient Unit Heaters Will Eliminate "Dead Spots" in Your Plant and Give Uniform Heat • •

Airtherm Steam Unit Heaters will distribute air evenly from the fans through the condenser into every remote corner of your plant, eliminating all "dead spots" and guaranteeing you full efficiency from every ounce of steam. The deflectors are designed so that air velocities are increased without the necessity of extra power.

Airtherm Steam Unit Heaters are now equipped with copper coils for longer life, durability, and resistance to corrosion. They are individually controlled for efficient, economical operation. Save fuel with an Airtherm!

Write for bulletin showing detailed specifications and delivery estimates.

For Vertical Delivery

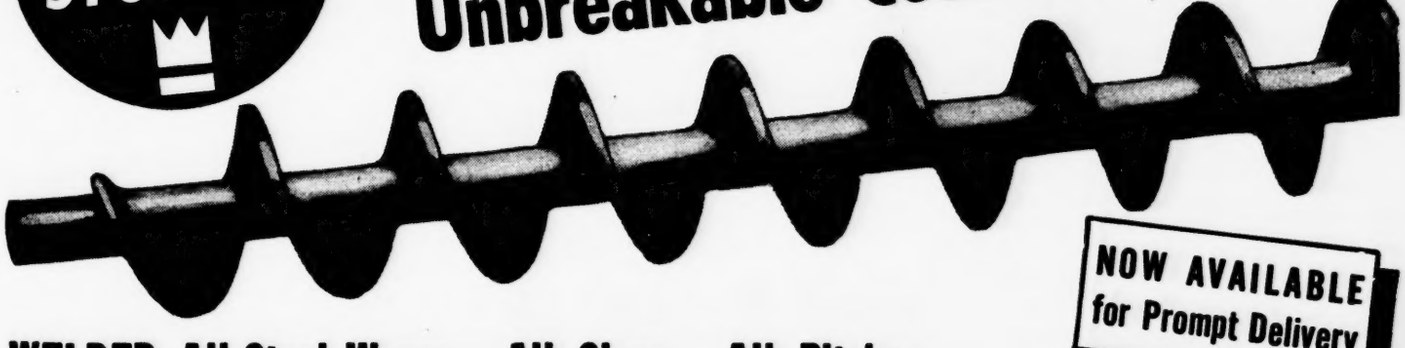
For Horizontal Delivery

AIRTHERM MANUFACTURING COMPANY

722 South Spring Avenue • Saint Louis 10, Missouri

For **STOKERS**

The CROWN Unbreakable Coal Feed Screw



NOW AVAILABLE for Prompt Delivery

WELDED All-Steel Worm—All Sizes—All Pitches

★ For replacement or production needs, Crown is now able to offer for prompt delivery its all-steel Coal Feed Screw. Available with right or left hand screw, in all sizes and pitches, tapered or straight, and in combinations of pitches. For both domestic and industrial stokers, the Crown Coal Feed Screw insures longer and continuous operation because it is all-steel and because it is machined so smoothly that wear is reduced to a minimum. This smooth surface is your assurance, too, that coal will flow freely and easily through the flights. Prompt delivery is possible because production requires less time on Crown's automatic machines and because the steel used in Crown's Coal Feed Screw while critical, is more easily procured.

In ordering give complete specifications on size and design.

CROWN IRON WORKS COMPANY

1229 Tyler St., N. E. *Since 1878* Minneapolis, Minn.

PACKAGED Gas Heating CONTROLS for Homes and Industry

Automatic Control Package Set ready for installation... everything included for the positive remote control of gas fuel supply. For manufactured, mixed, natural or liquefied petroleum gas. Used on central and floor furnaces, gas radiators, gas ranges, water and wall heaters, circulators, etc. Set consists of B-60 all-gas-operated control valve; integral pilot generator for safety, ignition and source of power (no outside current required); 30 ft. wire; Trimtherm thermostat with or without thermometer and/or Timer. Setting range 50-90° F., ½° F. differential. Three types illustrated.

PLAIN THERMOSTAT SET
No Thermometer

STANDARD THERMOSTAT SET
With Thermometer

TIMER-THERMOSTAT SET
Maximum setting 13½ hrs.

Other types of Package Sets include: T-30 Series (containing K-3B magnetic "on and off" valve, Metrotherm thermostat, transformer, 30 ft. wire) for gas-fired boilers, floor furnaces, conversion burners, warm air furnaces, etc. T-40 Series (containing D-40 dual gas valve, dual thermostat, transformer, 30 ft. wire) for automatic hi-low-off firing. For complete specifications, request Catalog 52B from Factory Branch or Distributor nearest you, or write direct to:

GENERAL CONTROLS
501 ALLEN AVENUE GLENDALE 1, CALIF.
BRANCHES: Atlanta, Boston, Philadelphia, San Francisco, Denver, Chicago, Kansas City, New York, Cleveland, Detroit, Dallas
Distributors in Principal Cities

(Continued from page 104)

William R. Teller was appointed director of research and development of **The Bryant Heater Company,** Cleveland. Mr. Teller was assistant director of the testing laboratories of the American Gas Association, also located in Cleveland, where he has served in various capacities since 1930. He was graduated from Case School of Applied Science in 1927 with the degree of bachelor of science in mechanical engineering and spent the following three years gaining field experience in gas and oil production in western Kentucky.

William R. Teller

Shortly after Pearl Harbor, Mr. Teller was placed in charge of the newly organized war products department of the A.G.A. testing laboratories. He was directly responsible for development of numerous controls and instruments of the Army and Navy and the Office of Scientific Research and Development.

A greatly expanded research program is being undertaken by The Byrant Heater Company under Mr. Teller's direction. It will embrace improvements in gas heating equipment, range lighters, controls and appliances. The company is a member of **Dresser Industries, Inc.**

Kieley & Mueller, Inc., North Bergen, N. J., manufacturers of pressure and flow control equipment, announce the appointment of **Clifford B. Ives** as chief engineer. He has been closely associated with control problems for the past 15 years and will direct the expansion of Kieley & Mueller products in this field.

Clifford B. Ives

Clarence A. Rundall

Clarence A. Rundall has been appointed Manager of the Stoker Division, **Peerless Manufacturing Co.,** Louisville, Ky., succeeding Robert B. Lyman who resigned as of October 28.

He was with Electric Furnace-Man, Inc., for 13 years. For the past 4½ years he represented the Minneapolis-Honeywell Regulator Company as special factory representative, covering stoker manufacturers exclusively.

Calgon, Inc. has announced the return to the textile and power field of **Maj. W. D. "Doug" Smith,** formerly with Calgon representatives Eshelman & Potter, Birmingham and Charlotte, prior to entering army service two years ago. Maj. Smith, whose home city is Greenville, S. C., served in the Chemical Warfare Service at Fort Blanding, Fla. He returns to aid Eshelman & Potter with water problems in the textile and other fields of the South, and for a short time will check home office researches on water conditioning at Pittsburgh.

(Concluded on page 108)

BRANCH OFFICES

IN PRINCIPAL CITIES

MASSACHUSETTS

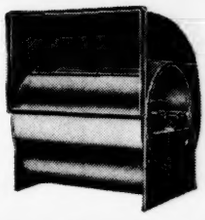
COMPLETE RANGE OF

SIZES & CAPACITIES

HEATING AND VENTILATING PRODUCTS

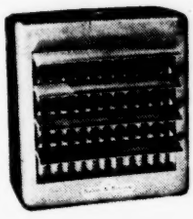
BLOWERS

Squirrel Cage type, Single and Double width. Sizes from 12" to 96" wheel diameter.



BLOWERS

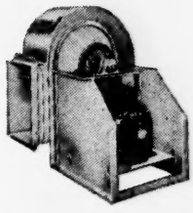
Power Fixed Back Curved type, Single and Double width. Sizes from 12" to 75" wheel diameter.

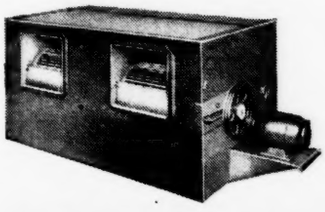


BELT DRIVE VENTILATING UNITS

Propeller Fan type Unit Heater, both Horizontal and Vertical Projection type.

Complete packaged units. Quiet, compact, for capacities 200 to 10,000 C. F. M.





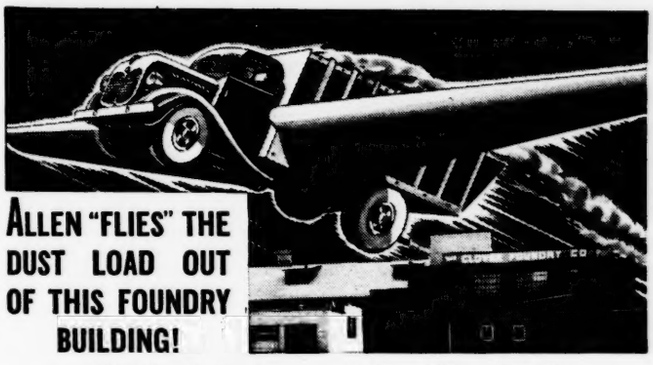
UNIT HEATERS

Blower Type, ceiling and floor mounting. Also available as ventilating units with filter and damper sections.

PROPELLER FANS

Belt Drive and Direct Drive types. Sizes 12" to 48". Accessory items consisting of Shutter and Fan Houses.

4901 Hamilton Ave. • THE BISHOP & BABCOCK MFG. CO. • Cleveland 14, Ohio



ALLEN "FLIES" THE DUST LOAD OUT OF THIS FOUNDRY BUILDING!

..a Typical Assignment for Allen Engineers

When this vast building of the Clover Foundry Company at Muskegon, Michigan was originally built it was provided generously with roof ventilators. Subsequent operation and war time urgency for pushing up production of cast iron piston rings proved the existing ventilation inadequate to maintain a working atmosphere conducive to high operating efficiency. The Clover management turned to Allen and Allen made a true psychrometric survey. Much of the former equipment came off the roof and up went six Allen Type "H" Roof Fans—four 60A units over the shake out area; one 48A unit over the sand handling equipment; and one 48A unit over the cupola floor.
Result: Atmospheric dust count was reduced to a point well within the limits necessary for the maintenance of an hygienic atmosphere. Allen men have the right attitude toward ventilating problems. They look with complete realism on the problem and are free to recommend the right course. *The Allen Corporation, 9751 Erwin Avenue, Detroit 13, Michigan.*

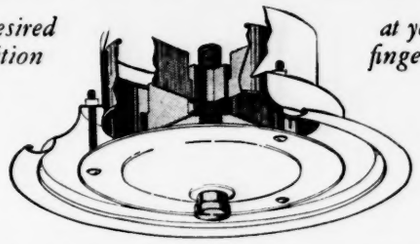
THE *Allen* CORPORATION

ENGINEERED VENTILATION FOR INDUSTRY

KNO-DRAFT

PROVIDES MAXIMUM EFFICIENCY
THROUGH CONTROLLED AIR DIFFUSION

Any desired condition — *at your finger tip*



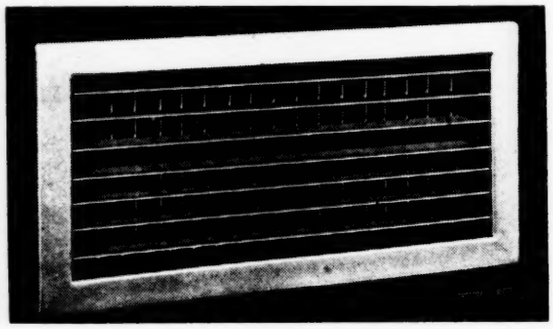
KNO-DRAFT *Type K Adjustable Air Diffuser with Type D Volume Damper.*
Patented

All Kno-Draft Air Diffusers are also equipped with *air direction* adjustment to suit seasonal or individual requirements. Their engineered design insures more effective room air mixing, more uniform room temperature and controlled, noiseless, draftless air diffusion at low cost.

Write for descriptive folder E.

W. B. CONNOR ENGINEERING CORP.

114 East 32nd St. — WB CONNOR ENGINEERING CORP. — New York 16, N.Y.



NO COSTLY "CALL-BACKS"

when you use

Waterloo AIR DIFFUSERS

You never have to go back on a job to replace registers and grilles for correcting air distribution, when you use Waterloo Air Diffusers.

Instantly Adjustable TO INSURE CORRECT DISTRIBUTION

The exclusive INDIVIDUALLY ADJUSTABLE BLADES on each Waterloo grille permit any variety of adjustment of air flow, even after the grilles have been installed. With ONE grille you can focus air flow in any direction, up, down, right or left—or diffuse it in all four directions at the same time—and can cut or lengthen the air throw, as desired.

Streamlined Blades Reduce Noise

Because of Waterloo's special streamlined blades, high velocity air is handled without grille noise or turbulence. Waterloo installations are quiet, draft free—make SATISFIED customers. And after the war, Waterloo's new and improved type "grilles of the future" are going to be even further ahead of the parade.

WRITE today for full information, and name of your nearest Waterloo representative.

Waterloo REGISTER CO.

Established 1902

Waterloo, Iowa—Seattle, Wash.

Representatives in All Principal Cities

(Concluded from page 106)

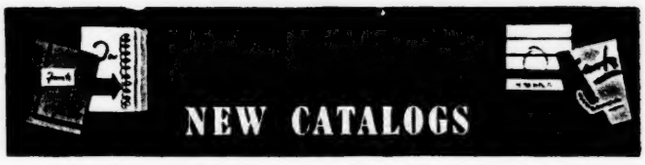
F. C. Harry Vaughan has been added to the mid-west sales office of the **Yarnall-Waring Co.**, 510 N. Dearborn St., Chicago. In addition to 6 years industrial sales work, he has served for 14 years as chief engineer in three plants of a large western meat packing company.

F. C. Harry Vaughan

Joseph G. Magrath has been appointed manager of the Chicago district sales territory, **American Machine and Metals, Inc.**, East Moline, Ill.

Mr. Magrath is a graduate of mechanical engineering at Drexel Institute of Technology and has been associated with various wood product manufacturers, and more recently as sales engineer and merchandising manager for Air Reduction Sales Company, New York. He is a member of the Society of American Military Engineers, American Society for Metals, and American Welding Society.

Headquarters for new Chicago district office is 310 South Michigan Avenue in that city. The divisions of the company under his supervision include DeBothezat Fans, Tolhurst Centrifugals, Troy Laundry Machinery, and Riehle Testing Machines.



Properties of Rubbers

Information Bulletin No. 8000, a two-page leaflet on the property relation of natural and synthetic rubber. Gives thorough analysis of the properties of the two materials.—*The B. F. Goodrich Co., Akron, Ohio.*

Resins and Plastics

Illustrated folder describing the properties and suggested applications of Geon resins and plastics. Material can be used as a coating on fabrics or pipes.—*The B. F. Goodrich Co., Akron, Ohio.*

Speed Reducer

Bulletin 1824 entitled "A Complete Data Book on Worm Gear Speed Reducers for Industrial Applications" contains 100 pages with photographs, dimensions, line drawings, engineering data, ratings, and similar information.—*Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.*

Industrial Paint Finishes

An illustrated folder, with samples of paint colors, on industrial enamels for pipe line identification, and paint and varnish for the decoration of all surfaces. In addition, separate illustrated folders are available with complete information on mill white, marine coatings, and aluminum coatings.—*Quigley Co., Inc., 527 5th Ave., New York 17, N. Y.*

(Continued on page 109)

Insulation

"Insulation and Your Home," a 24-page illustrated booklet, written in popular style, contains information of value to the home owner.—*National Mineral Wool Association, 1270 6th Ave., New York 20, N. Y.*

Electronic Controls

Two illustrated bulletins are available to describe a development in electronic controls. Bulletin No. 396 of 12 pages explains how the Duo-Stat can save fuel dollars. The device is claimed to be applicable to steam, hot water and warm air heating. A number of applications are illustrated. However, Bulletin 396A of 16 pages contains complete technical and installation data. It contains specifications, ratio of Duo-Stats required for specific outdoor base temperatures, and indoor and radiator temperatures, for various types of heating systems. A number of typical connection diagrams are shown.—*Johnson Service Co., Milwaukee 2, Wis.*

Compressed Air for After-Cooling

Bulletin 98 with operating drawing in color to describe a new method of compressed air after-cooling which the manufacturer claims will save over 96% of the water consumed by previous methods.—*Niagara Blower Co., 6 E. 45th St., New York 17, N. Y.*

Air Conditioning

A 16-page illustrated booklet on "How to Plan Your Post War Air Conditioning Today." It outlines the principal factors that must be considered when planning air conditioning for a specific application.—*Westinghouse Elevator Co., 150 Pacific Ave., Jersey City, N. J.*

Explosive Rivets

A manual has been prepared on the use of explosive rivets in peacetime production jobs. The rivet is used in places that are difficult to reach, and are exploded by means of an electric riveting iron. The explosion draws up the plates to be held, into a tight grip. Peacetime applications include ducts which can only be reached from one side, and in the construction of refrigeration cabinets.—*E. I. du Pont de Nemours & Co., Inc., Explosive Department, Wilmington 98, Del.*

Heat Exchange Equipment

Three standard sized catalogs: Bulletin SPA 7, devoted to the company's Spasaver, a vertical flow unit heater; bulletin WC5, giving information on the company's Strata-flo water coolers; and bulletin 3B, covering Wat-R-Miser and the company's evaporative condensers. Each bulletin contains descriptive, capacity and engineering data.—*Drayer & Hanson, Inc., 738 E. Pico St., Los Angeles 21, Calif.*

Air Filters

The complete line of Agitair air filters is illustrated and described in Bulletin AF 44-1 of 16 pages. The filters are designed for heating, ventilating air conditioning and industrial work, and for grease extraction.—*Air Devices Inc., 17 East 42nd St., New York 17, N. Y.*

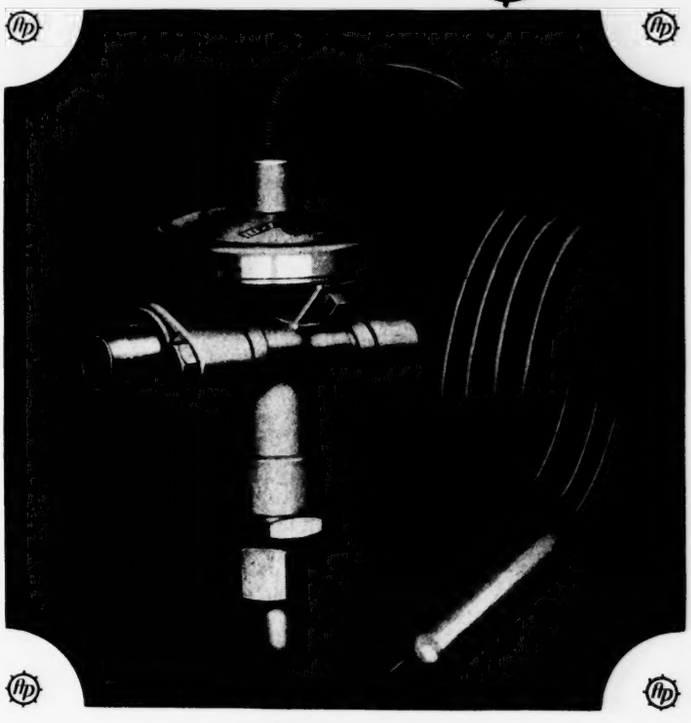
Speeding Reconversion

A new method of industrial lofting for producing, with accurate templates, a variety of products, is described in a 12-page illustrated bulletin. It involves the reproduction of full-size detail drawings directly on tooling materials. Manual duplication of drawings is avoided, and time reduced for converting war plants to peacetime work. — *Template Reproduction Co., 401 N. Broad St., Philadelphia 8, Pa.*

(Concluded on page 110)

Dependability doesn't happen...

IT'S *BUILT INTO* EVERY AP VALVE



AP MODEL 215
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Designed for large commercial refrigeration and air conditioning applications, Model 215 has a capacity range of 3 to 6 tons Freon, and 6 to 12 tons Methyl or Sulphur. Available with or without equalizer, it is ruggedly built, super-sensitive with its extra large area diaphragm and can be installed in any position. Easy installation, adjustable superheat, simplicity of inspection and adjustment are other features that add to its popularity among refrigeration engineers. Write for complete bulletin No. 408.

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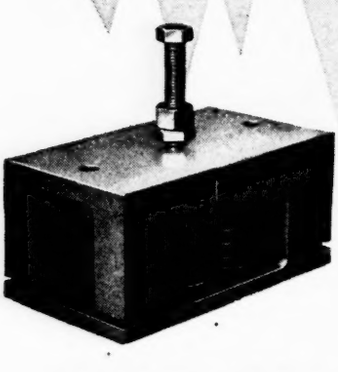

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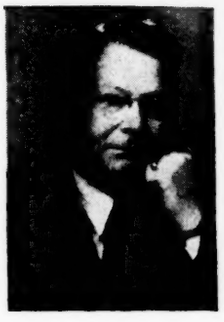
(Concluded from page 109)

Heat Transfer Equipment

An illustrated booklet of 24 pages on heat transfer equipment. Besides information on various Downingtown heat exchangers, it contains valuable mechanical design formulas, figures on heat transfer rates, tube sheet layout tables, and an article on evaporators and freezing systems.—*Downingtown Iron Works, Downingtown, Pa.*

Getting Personal



P. Alfred Croney

P. Alfred Croney, author of the blue-print section on Central Heating (page 65), was born in Wilmington, Del., and attended the public schools of that city. After moving to New York City, he studied at Cooper Union and at Columbia University.

Mr. Croney moved to Philadelphia, Pa., to work in the engineering department of Dodge & Day (now United Engineers & Constructors). For 5 years prior to World War I, he was mechanical engineer for Richard Gilpin, consulting engineer, and during the war was with E. I. duPont on construction work and later in the manufacture of smokeless powder. He then went with United Engineers & Constructors, then known as Day & Zimmerman.

In 1935, Mr. Croney was employed by the Housing Division of the PWA as mechanical engineer. Three years later he was Chief Mechanical Engineer for the U. S. Housing Authority, and following the reorganization of this group, he was transferred to Region I, Federal Public Housing Authority, Boston, as Senior Mechanical Engineer. He holds that position at present.

In addition to his housing experience, Mr. Croney has specialized in hospital and institutional work for a number of years, designing and supervising the installation of mechanical and electrical equipment.

Arthur C. Stern

Arthur C. Stern (Atmospheric Pollution Through Odor, page 53) was born in Petersburg, Va., and moved to Yonkers, N. Y., where he obtained his public school education. In 1930, he received his M.E. degree from Stevens Institute of Technology, and three years later his M.S.

After two years of engineering valuation work, he was placed in charge of the New York City Health Department's Air Pollution Survey which lasted two years and employed 250 men. Following a year in the publishing field he was employed by the New York City Municipal Civil Service Commission. In September, 1942, Mr. Stern became chief engineer of the Division of Industrial Hygiene of the New York State Department of Labor. He is concerned with dust, gas and fumes in industrial work, and their control.

He has written many articles and engineering societies' papers.

COMING EVENTS

NOVEMBER 15-19—Third National Chemical Exposition will be held at the Chicago Coliseum, Chicago, Ill. Sponsored by Chicago Section of the American Chemical Society. Headquarters for the show at 330 So. Wells Street, Chicago 6, Ill.

NOVEMBER 27-DECEMBER 1—Annual meeting of the American Society of Mechanical Engineers to be held at the Hotel Pennsylvania, New York City. Secretary, Clarence E. Davies, 29 W. 39th St., New York 18, N. Y.

NOVEMBER 27-DECEMBER 2—16th National Exposition of Power and Mechanical Engineering, to be held at Madison Square Garden, New York City. Charles F. Roth, president of the International Exposition Company, New York, is manager of the Exposition.

DECEMBER 10-13—Annual meeting of the American Society of Refrigerating Engineers to be held at the Hotel Pennsylvania, New York City. Secretary, David L. Fiske, 50 W. 40th St., New York 18, N. Y.

DECEMBER 13-14—Annual convention of the National Warm Air Heating and Air Conditioning Association, to be held at the Hotel Statler, Cleveland, Ohio. Further information from George Boeddener, Managing Director of the Association, 145 Public Square, Cleveland.

JANUARY 8-12—Annual meeting and engineering display, Society of Automotive Engineers, Book-Cadillac Hotel, Detroit.

JANUARY 22-24, 1945—51st Annual meeting of the American Society of Heating and Ventilating Engineers, at Hotel Statler, Boston. Secretary, A. V. Hutchinson, American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York.

JANUARY 22-26 — Winter technical meeting of the American Institute of Electrical Engineers, 29 West 39th St., New York, N. Y.

ARMY - NAVY E AWARDS

Henry Valve Company, Chicago, Ill.

The DeVilbiss Company, Toledo, Ohio. (Third award)

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PURITY of water is of prime importance, whether the water is for human consumption or for industrial use. But the purest of well water is subject to contamination if the pumping mechanism requires oil or grease below the surface. Many Public Boards of Health and industrial chemists have stipulated the use of water-lubricated pumps in order to eliminate the possibility of oil and grease contamination underground.

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The Peerless Water Lubricated Turbine Pump completely eliminates the use of oil underground; yet the line shaft is thoroughly lubricated by the well's own water. Thus, the *original purity* of the well water is retained. Moreover, this pump is the simplest of turbine designs and incorporates the imperial excellence that characterizes the heaviest-duty Peerless Pump.

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